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Volume 2 JULY, 1921 Number 7

Power Ditchers for Farm Drainage

By J. A. Howenstine

Jun. A. S. A. E. Secretary, Agricultural Engineering Company, Columbus, Ohio

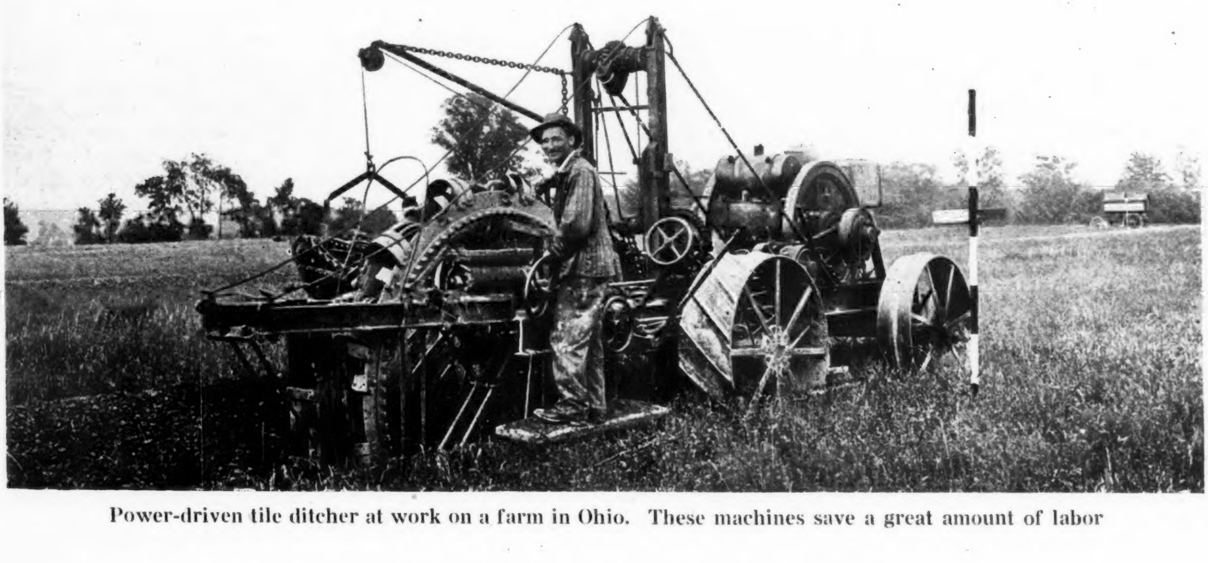
MUCH has been said and written about the theory of farm drainage, why land drainage helps crop production, how a drainage system is laid out, how grades are run, what kinds of tile are best, how tile should be laid, etc. But the actual problem facing the farmer who desires to drain his land is the actual removal of thirty or thirty-six inches of soil to the bottom of the trench. Farmers generally realize the benefits of drainage. They may differ as to the best way of draining land, but they know that it pays. The layout of the system, the hauling of the tile and its cost does not trouble him. It is not the cost of trenching that causes a farmer to delay drainage, but it is the actual physical excavation of the trench that holds up drainage for the average farmer.

The drainage laws of practically all states have placed satisfactory outlets at the disposal of the farmer. In order to avail himself of these outlets he must cover his land with a network of tile drains. He may either dig these trenches by hand or he may dig them with machinery. Digging by hand is slow, laborious work. Very little progress can be made in farm drainage if this method of installation is followed. It takes time. Hired labor is unsatisfactory—it is too difficult to direct and supervise. Very few contractors are willing to take farm-drainage contracts, and the actual impossibility to make headway, ditching by hand—getting the job done completely and on time—practically makes hand ditching impracticable. The only recourse left is to excavate the trenches by machinery.

Briefly speaking, there are two general types of power ditching machines, those operated by horse power and those operated by steam or internal-combustion engines. While horse-drawn ditchers save an enormous amount of labor, they are not wholly satisfactory because they will not grade the trench. As dirt removers they are satisfactory, but there is always a great amount of hard labor to be done to smooth up the trench and lay the tile. This is a hindrance to the busy farmer who wants to install his system in the shortest possible time and with a limited amount of labor.

The large power-driven excavator, or practically all types, can be successfully used on jobs involving the removal of large quantities of dirt. They are, however, not satisfactory for individual farm drainage. This work requires a special type of machine. It is wise to use a large excavator in the digging of a basement or in the excavation of a drainage or irrigation canal, but it would be foolish to use one of these machines to scrape the snow from one's front walk.

So it is with the excavator for farm drainage. The requirements for this machine are so different from those of large excavators that a special type has been developed. Briefly, there are two types of farm drainage machines on the market today. Essentially they operate on the same principle—a round, revolving, digging wheel drawn behind a tractor. These machines do good work, save a great amount of labor, but are subject to certain limitations. There are big possibilities in the future development of a small,



Power-driven tile ditcher at work on a farm in Ohio. These machines save a great amount of labor

powerful, easily handled farm ditcher. The power ditcher which will meet the requirements of the average farmer as efficiently as the modern tractor is yet to be designed. A summer's experience in farm-drainage work has convinced me that the possibilities of development of this piece of farm machinery have been merely scratched. From the standpoint of the farmer and more particularly the drainage contractor, this machine must meet certain requirements, several of which will be pointed out and discussed here.

In the first place, the power farm ditcher is a machine that will not be owned and operated by every farmer. In the past, these machines have been owned and operated by persons who have made their living by drainage contracting or by farmers who operated the machine during the slack season on the farm. From the standpoint of actual drainage work accomplished, this method of operation has not been satisfactory. More machines must be introduced, they must be educated to see the advantage of power drainage over hand drainage. If farmers can be organized to buy cooperatively a power ditcher and drain their land, a great step will be taken towards more perfect farm drainage.

The essential parts of this machine are (1) a power plant, (2) a transmission for both the digging apparatus and for the purpose of moving the machine over the ground, (3) a frame or chassis, and (4) a digging apparatus with a power grading device.

The machine should cut a perfect trench at one crossing of the ground. A machine that does not completely cut, clean, and smooth the trench for the tile is defeating its own purpose. Too much time will be wasted in expensive hand labor in completing the operation.

The machine should be designed to cross its own trench without difficulty and without assistance. In the installation of a system it is often necessary to cross old trenches or main line. The machine that will cross such trenches without assistance and without effect on grade is most desirable.

Provision should be made for ample bearing of tractive parts on all types and conditions of soil. Extension rims for wheels and easily attached extension supports for caterpillar treads should be provided for wet and mucky soil.

The ideal source of power is from a slow-speed, heavy-duty, four-cylinder engine. The freedom from vibration and the steady flow of power makes this type of power plant desirable. The engine should be watercooled, ample provision being made for cleaning the waterjackets and radiator. Dirty water from the trenches will, in nine cases out of ten, be used for cooling so some provision should be made for cleaning the cooling system. An accurate governor must be provided for the load on the power plant of a ditcher varies over wide limits.

The transmission for both the digging apparatus and the tractor should be simple, strong and enclosed. Variable speeds must be provided, ranging from three to twelve feet per minute while digging and as near two to three miles per hour on the road as is possible with a heavy machine. The variation of soil types and the different depths of digging must be amply taken care of by a selective spur gear transmission or possibly a friction transmission.

Provision should be made for using the power for belt work. Many times during the year it is possible to use the power of the ditcher engine for sawing wood, filling silos, grinding feed, and the like. It seems reasonable, too, that the digging apparatus could be detached from the tractive part, thus enabling the operator to use the machine as a tractor as well as a ditcher.

It is in the digging apparatus itself that the greatest possibilities for development are held. Laying the tile and backfilling the trench are separate operations with the present power ditchers. A machine with a tile-laying device and the incorporation into the machine of conveying apparatus to backfill direct from the excavator is a possible development. Two of the most laborious tasks connected with drainage would thereby be eliminated.

The grading device for the digging apparatus must be power driven. It must be accurate, easy to control, and positive in action.

The digging apparatus which will accomplish its purpose with the least removal of dirt is the most efficient. It should be designed to cut a trench exactly large enough for the size of the tile intended for the line. It is entirely possible to make this apparatus adjustable for different widths of trenches. Sloping trench walls and the minimum excavation for specific tile sizes should be the end worked for in the design of excavating apparatus. The bottom of the trench should be left smooth so that the tile will naturally lay in perfect alignment.

Breakage in the digging apparatus will always be experienced but it should be reduced to the minimum by the use of high-grade steel properly designed to withstand the strain liable to be thrown upon it.

The Divining Rod

THE idea of a "divining rod" or some other instrument that may be used as a means of finding buried treasure, mineral deposits, and underground oil or water is a superstition that continues with marvelous persistence in spite of the lack of tangible results from its employment.

It may be said without qualification or exception that no rod or instrument has yet been devised to find buried treasures, nor any instrument that will indicate the presence of gold, silver, copper, lead, zinc, or other non-magnetic metals, or their ores, that are hidden from view under ground.

Iron, nickel, and some minerals that contain these metals are magnetic, and the dip-needle or miner's compass has been adapted to use in prospecting for these metals. Such an instrument can be purchased, but special training is required to enable anyone to use it successfully.

No instrument other than the drill has been devised that will indicate the presence of water or oil underground. In determining the probable existence of underground supplies of these liquids geologists are guided by their knowledge of the relation of beds of rocks visible at the surface to beds that contain oil or water at other places in the same general region. They also make use of the recognized relation of occurrences of oil or water to certain structure (folds, faults, etc.) in the rocks, and of surface indications, such as oil seeps, springs, outflows of gas, etc. The United States Geological Survey has published as Water-Supply Paper 416 a report by A. J. Ellis, entitled "The Divining Rod, a History of Water Witching," which shows the uselessness of the instrument. This report may be obtained from the Director of the United States Geological Survey Washington, D. C.

Economy of Standardization

THAT lack of standardization in the farm-equipment industry places an enormous burden on the American farmer was pointed out by F. R. Todd, vice-president Deere & Company, Moline, Illinois, in a recent address in which he stated that through the elimination of unnecessary styles, varieties and sizes of farm implements and vehicles there has already been an annual saving of $10,000,000 to farmers, And it may be said in this connection that a start is only just being made in the direction of standardization of farm equipment.

Computing Fuel Requirements for Heating Buildings

By K. J. T. Ekblaw
Mem. A.S.A.E. Editor, "Power Farming Bureau," Chicago, Illinois

VARIOUS well-known rules are extant for determining the size, position, and location of the units of different types of heating systems, but the writer has been able to find very little information in regard to methods of determining the amount of fuel necessary to heat certain buildings. Such determination is usually mere guess work and any estimate that may be made generally has as a basis only figures derived from comparisons with actual installations of greater or less similarity; as a result the estimate is at best rather vague and is likely to vary widely from the actual required amount of fuel needed.

In 1914 Prof. E. H. Lockwood, of the Sheffield Scientific School of Yale University, formulated a rule which has a logical scientific basis. It is a complete rule depending on five definite variables: (1) Wall surface of building; (2) heat transfer coefficient for building material; (3) difference between interior and exterior temperatures; (4) length of heating year; and (5) heat units of fuel utilized for warming purposes, depending jointly on kind and quality of fuel and efficiency of heating system.

As a formula Prof. Lockwood's rule is stated as follows:

$$\text{Pounds of Coal Required per Year} = \frac{(m\,W + n\,G)\ (T\text{-}t)\ C}{D}$$

W = total exterior wall surface of building expressed in square feet. Ceilings are included only when space above is not heated. The wall surface of unheated portions of the buildings are not included.

G = total exterior glass area of heating part of building expressed in square feet. This area included the overall dimensions of window sash, and in glass doors the area of the doorway.

m = heat transfer coefficient for 24 hours. These values are standard values determined by Greene's method and as given by him.

Lath and plastered walls clapboarded	4.8
Brick walls 8 inches thick, furred and plastered	5.8
Same, 12 inches thick	4.8
Same, 16 inches thick	4.3
Concrete Walls, 12 inches thick, furred and plastered	6.2

n = heat transfer coefficient (24 hours) for glass

Single glass	25
Double glass	11

T = average temperature inside building during heating year for a residence. Its value may be taken at from 62 to 70 degrees Fahrenheit, depending on the amount of cooling at night.

t = mean daily temperature outside of building during the heating year. (See accompanying table.)

C = number of days in heating year, or number of days in calendar year that heat is required in building. (See table.)

D = thermal units per pound of coal usually employed in the heating system. For direct steam or hot water, under the conditions and care ordinarily exercised, 50 per cent of the heat value is efficiently utilized. For indirect steam, or hot water, or for warm-air furnace heating, this value is 40 per cent. Careful operation of the heater may increase these efficiencies.

In order to make this formula of general application the writer checked all values carefully and, using the records of the United States Weather Bureau, prepared a table indicating the length of heating year and the average daily temperature during this time for twenty-five cities of the United States, located centrally in areas which might be considered representative regional areas so far as weather is concerned. The heating period as given includes the number of days when the mean temperature was fifty degrees or below; this might seem a rather low figure but it must be remembered that this is the average temperature of the day, and that even when no fuel is being burned the interior temperature for various reasons is higher than that outside. The average temperature during the heating period was found by taking the mean of the average daily temperature over a record as indicated.

LOCATION	Record Period	Duration of Heating. Days	Average Temperature During Heating Period. Degrees Fahrenheit
Abilene, Tex.	1886-1905	104	45.8
Atlanta, Ga.	1879-1905	110	45.0
Bismarck, N. D.	1875-1905	212	23.6
Boise, Ida.	1878-89, 1899-1905	184	37.7
Burlington, Vt.	1873-1905	210	29.0
Cheyenne, Wyo.	1873-1905	224	32.2
Chicago, Ill.	1873-1905	189	33.6
Columbus, Ohio	1879-1905	173	33.6
Denver, Colo.	1873-1905	188	36.6
Helena, Mont.	1880-1905	195	29.7
Kansas City, Mo.	1889-1905	170	32.8
Lincoln, Neb.	1897-1905	174	31.8
Marquette, Mich.	1873-1905	226	24.5
Memphis, Tenn.	1873-1905	113	42.5

$$\frac{(4.8 \times 1750 + 25 \times 350)\ (70 - 33)\ 186}{} = 18900 \text{ pounds coal}$$

New Haven, Conn.	1873-1905	186	33.0
Pittsburg, Pa.	1873-1905	171	38.0
Portland, Ore.	1873-1905	167	42.0
Raleigh, N. C.	1887-1905	123	43.7
Reno, Nev.	1888-1905	174	38.3
San Francisco, Cal.	1873-1905	49	50.0
Seattle, Wash.	1894-1905	185	43.0
St. Louis, Mo.	1873-1905	153	39.4
St. Paul, Minn.	1873-1905	195	26.0
Syracuse, N. Y.	1903-1905	194	32.6
Washington, D. C.	1873-1905	159	38.7

A practical determination of accuracy of the formula was made in connection with a residence located in New Haven, Connecticut, the walls of which are clapboarded outside and covered with lath and plastered inside. The residence has a total exterior wall surface of 1750 square feet and a total exterior glass surface of 350 square feet. An average inside temperature of 70 degrees Fahrenheit was maintained, and from the accompanying table of average temperatures it is found that the average exterior temperature during the heating year of 186 days is 33 degrees Fahrenheit. The fuel used

was of the grade known as "Yard Pea" anthracite with a heat value of 12,500 B. t. u. per pound. These values, together with M and N, given previously as 4.8 and 25 respectively, were substituted in the formula as follows:

$$\frac{(4.8 \times 1750+25 \times 350)\ (70-33)\ 186}{12500 \times 0.50}=18900 \text{ pounds coal}$$

giving the amount of fuel required as indicated.

During the winter of 1912-1913 the owner kept a careful record of the actual amount of fuel used in heating the house. This record shows a total fuel consumption of 19,000 pounds, which is in remarkable agreement with the value as determined by the formula. It may be mentioned, incidentally, that through careful operation of the heating system the owner of the residence was able to reduce his coal bill materially through the use of the lowest grade of fuel.

The amount of coal required per day in the coldest weather is of importance in determining the size of heater to be installed. The general formula can be adapted, making

T = 68 degrees Fahrenheit
t = the minimum temperature outside
C = 1 day

Then the formula becomes

$$\text{Pounds of coal per day} = \frac{(m\,W + n\,G)\ 68}{D}$$

Agricultural Engineer in Commercial Work

By Stanley F. Morse

Member A. S. A. E. Consulting Agricultural Engineer, New Orleans, Louisiana

IN HIS article on "Opportunities for the Agricultural Engineer in Commercial Work" on page 67 of the March 1921 number of AGRICULTURAL ENGINEERING, it appears that Prof. Ives omitted some of the most important opportunities. Perhaps it may be said that the field I have in mind might be considered that of agronomy or farm management. Yet no agronomist or farm manager can be considered to be fully equipped for practical work unless he has a working knowledge of agricultural engineering. That does not mean that he must be a qualified specialist in drainage, irrigation, building construction, farm machinery, and the like. Neither does it mean that because he should have a practical understanding of business methods he should be a trained banker, lawyer, or merchant.

Investigations by the Office of Farm Management of the U. S. D. A. have demonstrated that a common reason for the failure of farming enterprises is lack of balance. This indicates that these farms or plantations were poorly planned. Many farms, indeed, appear not to have been planned at all but, like Topsy, they "just growed." Hence, to insure steady profits over a long period of years new agricultural enterprises should be properly planned, while going concerns now out of balance and not adequately stable and profitable should be carefully analyzed and reorganized. Here is a legitimate and promising field for the properly trained agricultural engineer with sufficient practical experience. It would be surprising to those who are not familiar with large scale agriculture if they could analyze with me the organization and operations of huge plantations involving investments of millions of dollars. The amount of losses or "leaks" that may be stopped by an experienced agricultural engineer runs into many more thousand dollars than the cost of his services.

In other industries many engineers have become managers and some of the leading technical schools now offer special courses in engineering management. So in agriculture there are numerous openings for competent managers. One of the limiting factors in agricultural development today is the reluctance of financiers to invest capital in agricultural enterprises because fully competent managers are not available. Hence, the practical agricultural engineer with some agronomy, farm management and business training, or the agronomist with agricultural engineering and business training combined with the proper personal qualifications and practical experience is well fitted for a position as farm manager. It may be interesting to note that the Morse Agricultural Service is now engaging in the management of agricultural enterprises as a specialty, operating various farms and plantations through resident managers under our central control. The advantage of this plan lies in the fact that we can use managers with good technical training and experience but deficient in business experience, the central office furnishing the standardized method of accounting, purchasing and selling and handling also the financing and legal matters. This is, of course, applying big business methods to agriculture and is applicable either to large farming enterprises or to groups of farms combined by their owners for efficiency and economy in operation.

FARM MANAGEMENT PAYS

To insure steady profits over a long period of years new agricultural enterprises should be properly planned, while going concerns now out of balance and not adequately stable and profitable should be carefully analysed and reorganized. Here is a legitimate and promising field for the properly trained agricultural engineer with sufficient practical experience. The amount of losses or "leaks" that may be stopped by an experienced agricultural engineer runs into thousands of dollars

Some Fundamentals of Stable Ventilation*

By **Henry Prentiss Armsby and Max Kriss**

Director and Associate, Institute of Animal Nutrition of the Pennsylvania State College

MUCH study has been given in the past to the mechanical aspects of stable ventilation and to the construction of efficient systems; but so far as the authors are aware, singularly little attention has been paid to the amount of motive power available for the operation of these systems. This is particularly true of that portion of it which is derived from the heat production of the animals, notwithstanding the fact that the latter may vary within wide limits and may at times constitute the sole motive power.

In the cooperative investigations upon animal nutrition which have been carried on at this institute during the past twenty years, a large number of direct determinations of the heat production of cattle under different conditions have been made. Numerous similar determinations have also been made by Kellner (*11*, *12*, *13*)[1] by the method of indirect calorimetry. A smaller number of results upon other species of farm animals are also on record. Upon the initiative and with the efficient cooperation of W. B. Clarkson, chairman of the Committee on Farm Building Ventilation of the American Society of Agricultural Engineers, we have attempted to work out a method by which these results may be applied to the problems of stable ventilation and the heat production in any specific case computed with a fair approximation to accuracy. The present paper contains the results of these endeavors.

The installation of an effective ventilating system must necessarily depend, first, on a knowledge of the scientific principles involved and, second, upon a study of the conditions of each individual case. As the amounts of pure air required by the different species of farm animals are different, the minimum volume of air movement through a stable must vary accordingly. The construction of a ventilating system must be based on the unit of air movement chosen and on the available motive power which is to insure the required supply of air.

The motive power utilized in stable ventilation is chiefly the passing wind and the heat and water vapor given off by the animals. It frequently happens, however, that the motive force due to the wind is very small or even zero. At such times the air movement is entirely dependent upon the motive power derived from a rise in temperature and from an increase in the moisture content of the air after it enters the stable. It is therefore important to know this minimum motive power—that is, the heat and water vapor supplied by the animals, as this knowledge is evidently fundamental in determining the proper dimensions of the ventilating system.

But the heat given off by farm animals, while serving as a motive power for ventilation, is also relied upon to maintain the temperature of the stable at a comfortable degree in cold weather. The Committee on Farm Building Ventilation of the American Society of Agricultural Engineers in its recent report (*8*) to the Society has emphasized very strongly the need of effective control of the temperature in farm buildings, as based on a number of its investigations. The committee found many barns with well-equipped ventilating systems which were not producing satisfactory results to the owners, not because of inadequate ventilation, but because of the fact that the buildings were too cold. All these facts point to the necessity of knowing how much heat is given off by the different farm animals and is available for heating and ventilating purposes.

Besides heat and water vapor farm animals give off carbon dioxid and some volatile organic products. Air once respired contains carbon dioxid in a quantity which makes it unfit to be breathed again unless very much diluted with pure air. It is chiefly the carbon-dioxid content of the air that serves as a basis for determining its degree of purity. In selecting a unit of air movement in the construction of a ventilating system it appears, therefore, that a knowledge of the average amounts of carbon dioxid produced by the different animals must be of not a little significance.

From what has just been said it is clear that the question of stable ventilation is a question of maintaining the proper purity of air in the stable as well as the proper temperature. Air supports the life of the animal. The air an animal breathes is as much an indispensable part of the feed it consumes as is the hay or the grain eaten. Within the animal body neither assimilation of food nor generation of energy can take place without the consumption of a proportionate amount of air. When the animals are outside they have plenty of pure air at their disposal; in the stable, however, the air is contaminated with the gases thrown off by them. Unless there is an air movement at a proper rate into and out of the stable, these gases—the carbon dioxid and the volatile organic product exhaled by the animals—will accumulate and may have injurious effects on them.

King (*14*) bases his estimates of the volume of air which should move continuously through stables, first, on the amount of pure air which must be breathed by different animals, and, second, on the standard of purity recommended by him. According to his computations a horse must draw into and force out of his lungs, on the average, each hour, some 142 cubic feet of air, the cow 117, the pig 46, and the sheep 30 cubic feet.

The standard recommended by King requires a degree of purity of air not lower than 96.7 per cent, that is, that the air in the stable shall at no time contain more than 3.3 per cent of air once breathed. Since the air coming from the lungs contains about 4.24 volume per cent of carbon dioxid and pure air 0.028 volume per cent, it appears that King's standard allows $4.24 \times 0.033 + 0.028 \times 0.967$, or 0.167 volume per cent of carbon dioxide. From the amounts of air breathed by the different animals given above, the rate at

$$\text{For horses } \frac{142 \times 100}{3.3} = 4303 \text{ cubic feet}$$

$$\text{For cows } \frac{117 \times 100}{3.3} = 3545 \text{ cubic feet}$$

$$\text{For swine } \frac{46 \times 100}{3.3} = 1394 \text{ cubic feet}$$

$$\text{For sheep } \frac{30 \times 100}{3.3} = 909 \text{ cubic feet}$$

*Cooperative investigations between the Bureau of Animal Industry of the United States Department of Agriculture and the Institute of Animal Nutrition of the Pennsylvania State College. Reprinted from "Journal of Agricultural Research," Washington, D. C., Vol. XXI, No. 5, June 1, 1921.

[1]Reference is made by numbers in parentheses to "Literature Cited" on page 155.

which air must enter and leave the stable to correspond to this standard is computed per hour and per head as follows:

It is not claimed that the standard of air purity and the units of air movement for the different animals given above are absolutely needed. While they probably afford a good gauge by which to be guided, they have been given here mainly to illustrate the method and the basis of their computation.

The maintenance of a flow of air through a building requires the continuous expenditure of energy, and the amount of this energy and the work done will be in direct proportion to the weight of air moved through the ventilated space and the resistance it is necessary to overcome in accomplishing this movement. To supply air to 100 horses, for example, at the rate of 4303 cubic feet per hour and per head, the necessary amount of work is that of moving through the stable each hour

$$\frac{4303 \times 0.08 \times 100}{2000}, \text{ or } 17.2 \text{ tons, } 0.08$$

representing the weight of one cubic foot of air in pounds.

The power used to accomplish the air movement through stables, as already stated, is chiefly the passing wind and the heat and moisture given off by the animals. The motive force due to the wind depends on its velocity, direction, etc., and is, in general, very variable and sometimes even zero. On the other hand, the amounts of heat and water vapor given off by animals are fairly constant under like conditions and must, therefore, be depended upon to cause a flow of air sufficient to supply the minimum amount needed. Since it is this minimum air movement that concerns us most, only the motive power derived from the heat and water vapor produced by the animals will be considered here.

The immediate cause of air movement into and out of a ventilated space is a difference of pressure established between the air in the space to be ventilated and that outside. The effect of the heat given off by the animals is to render the air of the stable relatively lighter than the air outside. This difference in density causes a difference in pressure, which tends to maintain a continuous flow of air into and out of the stable.

The difference in pressure between the air in the barn and that outside resulting from a difference in temperature can be computed in the following way: When air is warmed its volume expands 1/491 of its volume at 32 degrees Fahrenheit for each degree Fahrenheit rise in temperature. This expansion tends to force out one cubic foot of air for each 491 cubic feet contained in the stable, and the air remaining will consequently weigh less than an equal volume outside by an amount equal to the weight of the air thus forced out. If, for example, in a stable containing 19,640 cubic feet, or one very nearly 40 by 40 by 12.3 feet, the temperature is raised to 57 degrees, as compared with 32 degrees outside, the air forced out by expansion will be $\frac{19{,}640 \times 25}{491}$ or 1000 cubic feet. In other words, the air remaining will weigh 80 pounds less than an equal volume outside. This means that the total pressure into the stable at the floor is 80 pounds greater than that exerted outward by the inside air; and, since the floor has an area of 40 x 40 = 1600 square feet, the pressure tending to force air into the stable at a floor opening and out at the ceiling is $\frac{80}{1600}$ or 0.05 pound per square foot.

Based on the foregoing considerations, the magnitude of the temperature effect in producing draft, according to King, is represented by the following equation:

$$\text{Cubic feet per hour} = 60 \times 60 \times 8\sqrt{\frac{T - t}{491} H},$$

in which

60 x 60 is the number of seconds per hour

8 is $\sqrt{2g}$, g being the value of gravity, 32.16 feet per second

T is the temperature of air inside

t is the temperature of air outside

H is the height of room or ventilator

1/491 is the expansion of air for 1 degree Fahrenheit

This equation gives the theoretical value of the air flow per square foot of cross section. The actual flow of air is, however, less than the theoretical, its relative value depending on the resistance which the moving air has to overcome. It appears from an examination of the equation that in order to determine the flow of air the height and the cross section of the ventilator and the difference in temperature between the inside and outside air must be known. On the other hand, from the unit of air movement chosen and the difference in temperature likely to exist the minimum size of the ventilator can be determined.

What difference in temperature can be maintained by the heat given off by the different animals when the ventilation is sufficient to supply the minimum amount of air needed is a question which will be considered later in its relation to heat emission.

The water vapor which the animals give off is under ordinary conditions taken up by the moving air and carried off as rapidly as it is formed. The addition of the water vapor to the air in the stable tends to make it lighter than that outside, and this effect serves as a measure of the influence of water vapor as a motive power in ventilation.

The higher the temperature of the air the greater is its moisture-holding capacity. The more moisture the air contains the lighter it is. Consequently, the motive power derived from the water vapor is greater the higher the temperature of the stable air and the more completely it is saturated.

The quantities of water vapor produced by the different animals are given later. The motive power derived from the moisture is much less than that derived from the heat; and, since its magnitude largely depends on the difference in temperature, it can be considered only as secondary in importance.

The function of the animal heat as a motive power for stable ventilation has already been considered. A second function of the animal heat is to keep the stable warm in cold weather. The optimum temperature to be maintained in the stable varies with the kind of animal and also with the ration. There exists also a certain relation between the heat given off by the animal and its thermal surroundings. For the purpose of estimating approximately the best stable temperature, both as regards comfort and economy, it appears desirable to turn to a consideration of the scientific principles involved.

Farm animals belong to that general class known as warm-blooded animals, whose bodies during health maintain a nearly constant temperature which is the resultant of two factors, thermogenesis, or the development of heat inside the body, and thermolysis, the loss of heat from the body, principally by radiation and conduction and as latent heat of water vapor. The external temperature tends to influence the outflow of heat, but the animal is able to regulate it by physical and chemical methods.

There is a certain external temperature, called the critical temperature, at which the outflow of heat just balances the necessary heat production of the animal as a result of internal work. Above this temperature the radiating capacity of the body surface is varied to meet the varying conditions; below it, this method of regulation is largely exhausted, and therefore more or less oxidation of tissue is required to maintain the normal temperature of the body.

It is a fact demonstrated by numerous experiments that the consumption of feed results in increasing the heat production of an animal. When an animal is fasting it produces a certain amount of heat due to the vital functions of the internal organs. This is generally termed basal, or fasting katabolism. When the animal is fed, its heat production is increased over that of the fasting state. This increment of heat brought about by the consumption of feed has been ascribed to various causes, one of which is the expenditure of energy in the digestion and assimilation of the feed, often collectively termed "work of digestion."

The more heat the animal produces the more cold it naturally can withstand without being compelled to oxidize body tissue in order to maintain the normal body temperature. This, in other words, means that the consumption of feed lowers the critical temperature, the effect varying with the nature and quantity of the feed. Animals fed heavily, as in productive feeding, can therefore withstand more cold, or have a lower critical temperature, than animals kept on a simple maintenance ration, while the critical temperature of the latter is higher than that of the fasting animal.

From what has just been said it appears that a ration sufficient for maintenance at a temperature higher than the critical may be sufficient for maintenance when the thermal surroundings are lower than the critical, because of the failure to meet the demand for heat. What the critical temperatures of the different farm animals are is therefore a question not only of physiological but also of economic significance.

Critical Temperatures Estimated Approximately

It is apparent, however, that the critical temperatures of farm animals do not lend themselves to accurate determination. At best they are estimated only approximately. A summary of the results of different investigators on this subject (*3*, p. 312) shows that the critical external temperature for the horse is high as compared with that of ruminants, so that a ration which is sufficient for maintenance in summer may be insufficient in winter. The critical temperature for swine has been likewise found to be comparatively high (68 to 73 degrees Fahrenheit), which means that exposure to low temperatures may be expected to increase the actual maintenance ration and the heat production of swine, and this has been conformed by experimental results. On the other hand, the results in cattle seem to indicate that their critical temperature is rather low (much below 56 degrees), which means that cattle can be exposed to lower temperatures than horses or swine before their maintenance requirement will be affected and their heat production stimulated.

The production of meat or milk implies the consumption of large quantities of feed. Since the latter is the source of a large amount of heat, due to the "work of digestion," which has to be removed at a correspondingly rapid rate, it appears that heavy producers are better adapted to relatively cold thermal surroundings. Furthermore, since it is the aim in feeding such animals to induce them to eat as much feed as can be economically converted into useful products, it seems desirable, on the other hand, that the thermal surroundings should be low in order to maintain the appetite of the animals and, on the other, not so low as would cause wasteful oxidation for simple heat production.

The question whether winter feeding for fattening can be accomplished to better advantage in the stable than in the open shed has interested many investigators, and a considerable amount of experimental work is on record. The results (*1*) show in general that cattle are best adapted to exposure—that is, they produce as good results when exposed as when stable fed. Swine are least adapted to exposure, the gain of the animals exposed to severe weather being frequently negative, while sheep seem to take an intermediate place. These results are in full harmony with the findings given above as regards the critical temperature. Less decisive results have been obtained with dairy cows, but it appears fairly well established that for well-fed animals the need for warm stables has been somewhat over-emphasized.

Both theoretical considerations and the results of experience show that a certain excess of heat production over that absolutely required to maintain the body temperature is likely to be advantageous, both by promoting the comfort of the animal and as providing a margin of safety. On the other hand, an unnecessarily high temperature tends to affect the appetite and general health of the animal. From this it follows that the best thermal surroundings for animals lie between these limits—namely, somewhat above the critical point, but not so much as to affect the appetite and thrift. These limits, evidently, will vary with the species of animal and with the amount and character of the ration. The best temperature surroundings for animals being fed high, according to King, are likely to lie between 45 and 50 degrees Fahrenheit, while for animals on a maintenance ration, the best temperatures may be between 55 and 65 degrees. For dairy cows having large udders only scantily clothed with hair and through which much blood must flow, a temperature as high as 50 to 60 degrees is considered as probably the best.

Whether the heat eliminated by animals is sufficient to maintain in the stable approximately these temperatures in cold weather when the air movement is at the proper rate will be considered on subsequent pages.

The discussions of the foregoing paragraphs make it evident that the heat produced by an animal may be regarded as the sum of two factors, first, the necessary internal work due to the vital activities of the internal organs and, second, the "work of digestion." The first gives rise to an amount of heat equivalent to the fasting katabolism, which varies with the species and size of the animal, while the second gives rise to an increment of heat due to feed consumption, which varies with the character and quantity of the ration. It is clear then, that no single standard value can be assumed as representing even approximately the heat production of any species.

Approximate Figures Are Given in Tables

When the fasting katabolism of an animal and the heat increment due to the feed eaten are known, it is evident that the total heat produced by the animal can be computed by simple addition. Experimental data are available from which it is possible to estimate more or less accurately the fasting katabolism of farm animals according to their live weights, and also the increment of heat due to the ration feed. These data have been used as the general basis for computing the heat production. The details of the method are best illustrated by the computation on subsequent pages of the heat production of dairy cows.

The reader should beware of being led by the apparently very exact figures of the tables on succeeding pages to ascribe to these data a greater degree of accuracy than they really possess.

In the first place they represent specific cases assumed to be more or less typical. The actual production of heat, carbon dioxid, and water by a given species will show wide variations from stable to stable, and in the same stable from time to time, according to the size of the animals, their degree of activity, and especially the amounts of feed which they consume.

In the second place, it is by no means intended to assert on page 354, for example, that every Jersey cow weighing 750 pounds and yielding 20 pounds of 5 per cent milk will produce exactly 16,313 calories of total heat. The computations have been made on the basis of average results from which those on an individual animal may vary considerably.

TABLE 1. FASTING KATABOLISM OF CATTLE

Live Weight	Calories per head	Live Weight	Calories per head
150	1690	1000	6000
250	2380	1250	6960
500	3780	1500	7860
750	4950		

This is especially true of the fasting katabolism. Moreover, the computations have been carried out to the nearest whole calorie so as to record the exact results of the calculation. In view, however, of the many possibilities of experimental error involved, it seems very questionable whether the last three digits are significant. Probably an estimate to the nearest thousand calories—that is, to one therm—would be all that is justified and would be sufficiently accurate for the discussion of all ventilation problems.

The data for the fasting katabolism of cattle, although obtained by indirect methods and not by actually starving the animals, are more trustworthy than those for any other species of farm animals for the reason that they are more abundant, are concordant, and are based largely on experiments with the respiration calorimeter by means of which direct determinations of the heat production were made. In these experiments the animal is usually fed two different amounts of the same feed, and the effect of this on the heat production—that is, the decrease of heat production per pound decrease of feed—is determined. From this it is estimated how much heat would be produced if all the feed were withdrawn, that is, if the animal were reduced to the fasting state.

The average given by Armsby (*3*, p. 711) for the fasting katabolism of cattle per 1000 pounds live weight is six therms or 6000 calories, and, as the fasting katabolism of animals of the same species has been found to be approximately proportional to the two-thirds power of their live weight, that of cattle is computed accordingly. Table I gives the fasting katabolism of cattle according to their live weight in terms of calories.

Table I. FASTING KATABOLISM OF CATTLE

The energy expended by cattle in the increased body activities connected with the digestion and assimilation of many feeding stuffs have been determined directly by varying the amount of the feeding stuff in the ration and by determining the heat production. From a comparison of two determinations the heat increment caused by a pound of feeding stuff can be determined. The data for the heat increment caused by different feeding stuffs are average figures computed by Armsby and Fries (*4*, *5*) from the results of their own experiments and those of Kellner and Kohler (*11*, *12*, *13*) on beef cattle and are given in Table II in calories per pound of dry matter. The corresponding figures for dairy cows would probably be somewhat less, but how much less has not yet been determined.

In its relations to stable ventilation the computation of the heat production of cattle is of special interest in the case of dairy cows, since in cold climates these animals are almost always stabled during the winter while beef cattle are quite commonly fed in the open. The computations for cows are therefore given in considerable detail in the following paragraphs.

Obviously, no single value can be given for the heat production of the dairy cow, since it varies widely according to the size of the animal and the amount of feed consumed. All that is possible is to select certain typical live weights and rations and to compute the corresponding heat production as illustrations of the method in its application to specific cases, such as may be found in good practice. The typical weights and rations upon which the computation of the

TABLE II. INCREMENT OF HEAT PRODUCTION BY CATTLE PER POUND OF DRY MATTER CONSUMED

Feeding Stuff	Experimenters	Energy Expenditure Calories
Roughage:		
Timothy hay	Armsby and Fries	354.7
Red clover hay	do	441.3
do	Kellner and Kohler	422.7
Mixed hay	Armsby and Fries	444.5
Alfalfa hay	do	530.3
"Grass hay"	Kellner and Kohler	474.0
Meadow hay	do	568.8
Rowen	do	434.6
Corn stover	Armsby and Fries	483.1
Barley straw	Kellner and Kohler	397.8
Oat straw	do	460.0
Wheat straw	do	516.2
Straw pulp	do	526.2
Concentrates:		
Corn meal	Armsby and Fries	583.3
Hominy chop	do	619.2
Wheat bran	do	533.9
Cottonseed meal	Kellner and Kohler	443.6
Linseed meal	do	547.9
Palmnut meal	do	456.8
Peanut meal	do	525.7
Beet molasses	do	448.2
Starch	do	566.1
Peanut oil	do	783.4
Wheat gluten	do	950.8

heat emission by dairy cows has been based are those suggested, at the request of Mr. Clarkson, by Prof. C. H. Eckles, of the University of Minnesota.

To compute, for example, the daily heat production by the typical Jersey cow giving twenty pounds of milk daily, it is only necessary to add to the fasting katabolism of a cow weighing 900 pounds the heat increment due to the ration consumed. According to Table 1 the fasting katabolism of a cow weighing 1000 pounds is 6000 calories, while that for one weighing 750 pounds is 4950 calories. From these figures the fasting katabolism of a cow weighing 900 pounds may be estimated with sufficient accuracy by simple proportion as being 5580 calories per day.

It remains to figure out the heat increment caused by the consumption of feed. By using the average percentages of dry matter in the feeds as given in Henry and Morrison's tables (*10*) it is found that the amounts of dry matter contained in the ration are:

In corn silage........................7.9 pounds
In alfalfa hay........................7.3 pounds
In grain mixture.....................5.4 pounds

Since the grain mixture consists of 4 parts of corn, 2 parts of wheat bran, and 1 part of linseed meal, the heat increment per pound of dry matter of the grain mixture (Table II) is: $1/7\ (583.3 \times 4 + 533.9 \times 2 + 547.9 \times 1) = 564.1$ calories.

The heat increment per pound of dry matter of alfalfa hay is 530.3 calories, and that of corn silage is assumed to be 483.1 calories—that is, the figure corresponding to corn stover—since no figure for corn silage is available. From these figures the total heat increment caused by the ration is obtained as follows:

Corn silage.............483.1 x 7.9 = 3816 calories
Alfalfa hay.............530.3 x 7.3 = 3871 calories
Grain mixture...........564.1 x 5.4 = 3046 calories

Total heat increment.............10,733 calories

TABLE III. TYPICAL LIVE WEIGHTS AND RATIONS

BREED	Live Weight lbs.	Daily Milk Yield lbs.	Daily Milk Yield Percentage of fat	Daily Ration Corn Silage lbs.	Daily Ration Alfalfa Hay lbs.	Daily Ration Grain Mixture[1] lbs.	Addit'l Linseed Meal lbs.
Jersey	900	20	5.0	30	8	6	
do	900	30	5.0	30	8	9	1
Holstein	1250	30	3.5	40	10	6	
do	1250	45	3.5	40	10	10	1

[1]Composed of ground corn 4 parts, wheat bran 2 parts, linseed meal 1 part.

TABLE IV. TOTAL HEAT PRODUCTION BY TYPICAL COWS PER DAY PER HEAD

ANIMAL	Calories
Jersey cow producing 20 pounds of milk	16,313
Jersey cow producing 30 pounds of milk	18,273
Holstein cow producing 30 pounds of milk	19,905
Holstein cow producing 45 pounds of milk	22,372

TABLE V. HEAT GIVEN OFF BY RADIATION AND CONDUCTION AND AS LATENT HEAT OF WATER VAPOR PER DAY PER HEAD BY TYPICAL COWS

ANIMAL	Heat Emission by Radiation and Conduction Calories	Latent heat of Water Vapor Calories
Jersey cow producing 20 lbs. of milk	12,235	4078
Jersey cow producing 30 lbs. of milk	13,705	4568
Holstein cow producing 30 lbs. of milk	14,929	4976
Holstein cow producing 45 lbs. of milk	16,779	5593

TABLE VI. WATER VAPOR PRODUCED BY TYPICAL COWS PER DAY PER HEAD

ANIMAL	Water Vapor Grams
Jersey cow producing 20 pounds of milk	6947
Jersey cow producing 30 pounds of milk	7782
Holstein cow producing 30 pounds of milk	8477
Holstein cow producing 45 pounds of milk	9528

TABLE VII. CARBON DIOXID PRODUCED BY COWS PER DAY PER HEAD

ANIMAL	Carbon Dioxid Grams
Jersey cow producing 20 pounds of milk	6525
Jersey cow producing 30 pounds of milk	7309
Holstein cow producing 30 pounds of milk	7962
Holstein cow producing 45 pounds of milk	8949

TABLE VIII. HEAT, WATER VAPOR, AND CARBON DIOXID PRODUCED BY TYPICAL COWS PER DAY AND PER HEAD

ANIMAL	Milk lbs.	Total Heat Emission Calories	Heat Emission by Radiation and Conduction Calories	Latent Heat of Water Vapor Calories	Water Vapor Grams	Carbon Dioxid Grams
Jersey cow	20	16,313	12,235	4078	6947	6525
Jersey cow	30	18,273	13,705	4568	7782	7309
Holstein cow	30	19,905	14,929	4976	8477	7962
Holstein cow	45	22,372	16,779	5593	9528	8949
Jersey cow on maintenance		9,788	7,341	2447	4169	3915
Holstein cow on maintenance		12,184	9,138	3046	5189	4874

Adding to this the fasting katabolism of the Jersey cow, 5580 calories, gives the total heat production per day as 16,313 calories.

Computed by this method, the total heat production by the cows per day per head is shown in Table IV.

The heat emission as computed above includes that given off by radiation and conduction and the latent heat of the water vaporized. The latent heat of water vapor, however, can hardly be regarded as available for ventilation purposes, inasmuch as under average conditions there is no considerable accumulation of condensed water, the water vapor being removed from the barn as rapidly as it is produced by the animals so that there is little chance for its latent heat to be liberated.

From the experiments on cattle with the respiration calorimeter it has been found that except on very heavy rations the latent heat of water vapor constitutes approximately 25 per cent of the total heat given off, while about 75 per cent is eliminated by radiation and conduction. On this basis, the heat emission by radiation and conduction and as latent heat of water vapor per day per head for cows has been computed (Table V).

The computation of the amount of water vapor produced by an animal when the latent heat of the water vapor is known is a very simple matter. The latent heat of one gram of water vapor is 0.587 calorie. By dividing, therefore, the calories of latent heat of water vapor by 0.587 the number of grams of water vapor produced is obtained. In the foregoing cases the computed amounts per day and per head are as in Table VI.

Since carbon dioxid is a product of combustion, however slow it may be, within the animal body, it is natural to expect that a more or less definite relation between the heat production and the output of carbon dioxid must exist. From the accumulated data of the heat emission and carbon dioxid production by cattle determined directly by means of the respiration calorimeter at this Institute, the relation of the carbon dioxid produced to the heat given off has been very recently established by Armsby, Fries, and Braman (*6*), who, on comparing the daily output of carbon dioxid and the heat production by steers and cows for 188 separate days, found that in each case the ratio of the carbon dioxid produced in grams to the total heat emission in calories was very close to 1 to 2.5 or 0.4, the mean ratio being 1 to 2.495. By making use of this factor the amount of carbon dioxid produced by cows in grams is computed by simply multiplying the calories of daily heat emission by 0.4.

The daily maintenance ration of cattle has been computed by Armsby (*2*) from a number of experiments in terms of metabolizable energy, which in this case also represents the total heat production, 10,500 calories being the average per 1000 pounds live weight. This, computed in proportion to the two-thirds power of the live weight, gives 9788 and 12,184 calories, respectively, as the daily total heat production on maintenance by the Jersey and Holstein cows of the assumed weights. The heat emission by radiation and conduction, the water vapor, and the carbon dioxid produced by cows on maintenance have been computed by the methods just described and are included in the summary of the results of the computations on dairy cows in Table VIII.

(To be concluded in the August number)

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Cultivating California Orchards

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CALIFORNIA may be truly called "The Land of Fruits." With its area of 100,000,000 acres, the size of the New England states and Ohio combined, it produces 840,300 acres of fruit. Every known fruit raised in the United States is or can be grown in California. Apples, almonds, apricots, berries, cherries, figs, olives, peaches, pears, plums, prunes, walnuts, oranges, dates, lemons, limes, pomelo, grapefruit, persimmon, pomegranate, grapes and currants are grown on a commercial scale. At least a dozen more kinds of fruit, such as the mango, loquat, banana, pineapple, Spanish madrona, strawberry tree, melon, pawpaw, tuna, prickly pear, tree tomato, and Kai apple, are grown on a small scale.

The soil of California, like the fruit, is of every known type. It varies from volcanic ash and blow sand to dry hard adobe and clay. The climate likewise varies from snow cap mountains the year around in the northern part of the state to a dry hot desert during every month of the year as we find in the Death Valley.

In one respect only is the handling of all orchards similar, that is, the irrigation.

California has an average yearly rainfall of only 20 inches, consequently practically every orchard must receive an artificial supply of water in order to produce a maximum crop of fruit. The problem of water supply has been taken care of in most every instance. Conservation of moisture, however, is a most important problem. Irrigation water is quite an item of expense and the water that evaporates or runs off is a total loss. It, therefore, behooves every rancher to get the full benefit of his water supply.

On account of various soil conditions the problem of handling this water varies but as a general rule cultivation as soon as possible after irrigation or rain is imperative.

Mr. McBride, the superintendent of the California Citrus Experimental Station at Riverside, says: "The orchardist of California has two problems that are controlling factors. namely, cultivation and fertilization. In general the light soils require additional plant food in the way of fertilizer, while with the heavy soils it is almost wholly a matter of cultivation."

The fertility of the light soils is kept up by the use of manure, commercial fertilizers and cover crops. The cover crop is sown in October or November and turned under in February or March immediately after the winter rains cease. At this time it is very essential that the surface of the soil be mulched in order to prevent evaporation. Where clean cultivation is practiced the soil is cultivated after each winter rain.

It was with the knowledge that cultivation was one of the controlling factors in fruit production and more care and attention was given it than any other one problem that the disk harrow shown in Fig. 1 was designed and built.

While this harrow does not depart from old established principles, it has the unique and prominent features necessary to make it an efficient orchard tool.

The fruit trees, especially the orange and lemon, are pruned low and caused to spread out instead of growing up in the air. The same practice is being started in deciduous

The harrow solves the problem of cultivating under the low branches by virtue of its extended frame and tree guards, the disks being the highest part

fruits—such as apple, peach and prunes. Prominent deciduous fruit growers have told me they have found, as have the citrus men, that by pruning their trees low they get the benefit of the low fruit wood which is considered by them the finest on the tree, in addition to lowering their picking cost by having the fruit near the ground.

The branches of the trees in the case of oranges are but a few inches from the ground and the ripe fruit sometimes lies on the ground.

Formerly it was necessary to do all the cultivation of the soil under the trees by hand, a very laborious and expensive job. While a great many orchardists claim that it paid to hoe and dig under the trees after each irrigation the men that did so, however, were the exception rather than the rule. This has been next to impossible for the average grower on account of the expense, which ranges between $5 and $15 per acre, and the scarcity of labor.

The harrow it will be noted in the picture solves the problem of cultivating under the low branches by virtue of its extended frame and tree guards. The wide steel frame places the gangs out beyound the wheels of the tractor. The frame is low, and built so that the highest part of the harrow is the top of the disks. The tree guards just clear the top of the disks, making a very low implement which can get in under and up to the tree without injury to branches or fruit.

The orchardist can cultivate with this tool the soil under the trees as well as the soil in the center of the rows. He can prevent the loss of moisture through evaporation by making and keeping a mulch after each irrigation and rain. Weeds, trash, cover crops and manure can be cut up and mixed with the soil. Thorough aeration and pulverization will greatly assist in keeping the ground sweet and in good physical condition.

The harrow will make possible the elimination of hard work, as well as taking care of the orchard in a more ideal manner. Thus the efficiency of the orchardist is increased along with a better cultivation and larger yields.

Cultivation under the trees is generally done first. The harrow is then converted to a solid type and the centers of the rows disked. The gangs are easily set in by removing two bolts on each gang.

The tilting clamp is a prominent feature of this harrow. Vertical adjustment on each gang can be had by means of this clamp. The object of this adjustment was to make the harrow suitable for cultivating terraces and ridges.

Terraces are found in all cultivated orchards that are located on side hills. They are necessary to prevent washing. Formerly it was rather hard to keep from tearing them down when they were cultivated.

The tilting clamp may be made of further use in throwing dirt to the trees or pulling it away. Some orchardists make a practice of throwing dirt to the trees one year and pulling it away the next year.

Dirt may be thrown to the tree by extending the front gangs and setting the outer ends of these gangs down, in order to make them dig in. The rear gangs are left in the center of the frame.

Dirt may be pulled away from the tree by reversing the adjustments of the front and rear gangs, i.e., the rear gangs are set out and down while the front gangs are placed in the center of the frame.

We may say then in conclusion that this harrow presents features of design that will aid greatly in efficient cultivation of orchards. Any tool that increases production is bound to gain recognition.

It is the duty of the agricultural engineers to make every effort toward efficient production among farmers. Whether it be the service of education or power-farming-equipment production it matters little. Both are essential and dependent one on the other.

We believe that education in the use of well-designed power implements will go further toward cutting the cost of production, by the elimination of hand labor and increasing the efficiency of the tractor, than any other factor now working for the betterment of the American farmer.

Farm Tractor Ignition

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Member A. S. A. E. Recognized authority on tractor ignition

IT WILL not be the purpose of this article to cover those phases of tractor ignition which come within the spheres of electrical and mechanical engineering. The electrical engineer is concerned chiefly with the design and development of an instrument which will produce certain electrical characteristics. The mechanical engineer is interested in the efficiency and effectiveness of ignition as it relates to the power and economy of the internal-combustion engine. On the other hand, the agricultural engineer is more interested in the relation of the ignition to the results in more work, cheaper work, and better work that the tractor will do on the farm.

A cow with indigestion cannot produce milk. She may eat plenty of grass and grain and drink plenty of water, but with the elements of converting these absent there will be no milk. A cow is kept for the amount of milk she gives. A tractor with poor ignition cannot produce power. It may get plenty of good gasoline and oil and sufficient water for cooling, but unless there is effective ignition these will not be converted into power. And a tractor is owned for the power it gives.

Ignition in the tractor is of paramount importance. It may mean the difference between good hay while the sun shines or poor hay after the rain; a money crop harvested in its prime or gathered after severe depreciation. And much depends on the farmer himself as to what kind of ignition he will have.

There are various kinds of ignition used on tractor engines, and pretty nearly all of them seem to have been tried out. What the majority finally adopts, those things that in a measure become standardized by common usage, are generally the best. The tractor industry seems to have adopted pretty generally a high-tension magneto with impulse starter. And since that type of system is practically standard it is the only type that will be worth while discussing here.

The ignition system is more than a magneto. The magneto produces the electricity; high-tension cables carry this to the spark plugs; the spark plugs utilize it to produce a fire in the combustion chamber. Just as a chain is but as strong as its weakest link, an ignition system is only as good as its poorest unit.

Take the spark plugs. We ask a great deal of them. We place one end so that it may be bathed in rain or covered

with snow, the other end so that it is constantly warm and very hot. Under conditions such as these, combined with alternate vacuum and high pressure and in an atmosphere of atomized kerosene and lubricating oil, we expect it to have insulating properties capable of resisting voltages up to ten thousand or more. It must not crack under varying temperatures; it must not leak under high pressures; and the gap between the electrodes must not vary. It has quite a job.

What can be done to make its work consistent and efficient? Keep it clean. Whether it falters or fails or not, take it out of the engine occasionally and clean it thoroughly, and cleaning is not effective unless it is well done. It is the accumulation of carbon on the surface of the insulator that must be removed, as this may form a path of comparatively low resistance which will short-circuit the current. The writer has seen men supposed to be thoroughly acquainted with tractors and experienced with ignition attempt to correct spark-plug trouble by cleaning the carbon off the side and central electrodes of the plug. This should of course be done but it is the carbon on the insulator that is the real trouble maker. It hardly seems that it would be necessary to mention such an obvious thing as this but experience indicates that many do not understand it.

When the spark plug is being cleaned the electrode gap should be adjusted. This also seems to be such a little thing that many overlook its importance. Yet a few thousandths of an inch difference in this gap may mean a considerable difference in the way the engine idles or pulls. Different engines, different magnetos, and different spark plugs make it impossible to set an absolute standard for the width of this gap, but 0.02 to 0.03 inch are probably the high and low limits for most tractor engines. If the gap is too close the engine will not idle well; and if it is too wide the engine will not pull well. And sometimes there will be other irregularities in the operation. The tractor operator should determine by experimenting just what gap is best for his machine and its operating conditions and then maintain it there by periodic inspection and adjustment. Measurements as close as this cannot be made by the eye or with a yard stick any more accurately than one can determine the pressure in a tire by kicking it. To get long tire life use a pressure gauge; to maintain efficient ignition in the spark plugs use a thickness gauge.

It is safe to say that there are many tractors limping across the fields, wearing themselves out and using too much fuel and oil, when a few minutes spent in giving careful attention to the spark plugs would metaphorically, put them on their feet again.

And it is also true that there are many dollars worth of spark plugs in sheds and tool boxes of tractors that would be just as good as new from the operating standpoint if they were cleaned and adjusted.

Even though spark plugs are in good condition they cannot deliver a spark if the current of electricity never reaches them so the high-tension cables must be in good condition. These cables are, without exception, insulated with rubber, and it is well known that rubber rots and loses its insulating qualities in a year or two no matter how well it may be protected. Nevertheless, there are a few precautions that the operator should take to prolong their effective life and to insure against trouble in the working season.

Petroleum—oil, gasoline, or kerosene—will dissolve rubber, therefore, care should be taken to keep these away from the cables. That type of high-tension cable which is protected with a double-braided impregnated covering is not affected by oil nearly as badly as the plain rubber cables so frequently used. Should oil or kerosene get on the cables wash it off with gasoline and dry quickly with a clean cloth. Keep the terminals on both ends tight. These should be soldered if they become loose.

Do not allow the cables to lie or rub against any metal part of the engine. They can be gathered and held in wood clamp frequently or may be wrapped with tape. It is not advisable to attempt to repair with tire tape a cable which has cracked. This tape is simply an impregnated fabric without great insulating properties and a high-tension current will leak through easily. If a cable gets broken or the insulation becomes cracked, put in a new cable, and on general principles in the interests of efficiency and freedom from trouble during the busy season, put in a complete new set of cables every second spring at least; preferably once a year.

But after all the magneto itself, with its auxiliary the impulse starter, is the most important unit of the system. Some might say that it is also the least understood. But through the school of hard knocks and experience, and the efforts of the agricultural colleges and the manufacturers of ignition equipment, the farmer is rapidly learning what to do, and particularly what not to do, with his magneto. He is beginning to heed the doctrine "Leave it alone." He has realized that a magneto is an intricate mechanism which will not respond to the hammer and monkey wrench, nor yet to excited language or cursing. His is and should be the motto "Let George do it" when it comes to magneto repair.

About all that the tractor operator should attempt in the maintenance of magneto efficiency is to oil the instrument no more and no less than the manufacturer advises; to keep it clean externally; and to clean and adjust the platinum contact points periodically. Anything beyond those simple operations should be done by "George" in a well-equipped and specialized magneto service station.

Probably more magneto trouble is caused from too much oil than from any other cause. An excess of oil in some machines will soften and weaken the high-tension winding. It will cause the platinum contact points to blacken and burn. In the presence of the small flash which is always present at the contacts the oil partly burns and deposits of carbon form. This foreign matter continues to flash and burn and eventually platinum carbide is formed. This is hard and brittle and breaks away, causing the rapid deterioration of the whole contact point. Not only does the magneto produce weak and irregular sparks during this process but in a very short time the platinum is all gone and must be replaced at considerable expense.

While too little oil might cause too rapid wear of the bearings, it should be borne in mind that the main bearings of a magneto are ball bearings which require very little lubricant of any kind. The distributor bearing is frequently of the plain steel-in-bronze type, but this not only needs but a small quantity of oil but that is supplied in many magnetos by a reservoir and wick which needs replenishing but seldom. These bearings will run a long time without undue wear on the oil placed in them at the time the magneto was assembled.

Keeping the magneto clean externally is a simple task. It can be washed with a very little gasoline if necessary, but the best way is to wipe it with a clean cloth every few days to remove the accumulation of dust and oil. In some cases it is advisable to go a little farther than this by taking off the distributor block and carefully wiping out the oil and dust inside with a clean cloth just moistened in gasoline. The wear of the brushes forms a carbon dust which should be wiped out periodically.

Cleaning and adjusting the contact points of the magneto is a job which the tractor operator must learn to do carefully and accurately. It is one of those little things which means much. It is not possible here to cover definitely just how the contacts should be adjusted on all magnetos. It is fairly standard practice, however, among magneto manufacturers to recommend an opening of 0.02 inch. Whatever it is

in any particular case, it should be maintained religiously by careful measurement at least every two or three months.

First, clean the surfaces of the contacts. This may be done best by using a small brush and alcohol. A very satisfactory job can be done, however, by simply scraping the surface lightly with a knife blade, or, if there is nothing but oil on them, by inserting a piece of hard-surfaced paper between them, closing them against it, opening them, and withdrawing the paper. This last is known as the blotting method. In no case should the paper be drawn out from between the contacts while they are still together, as this may leave a shred of the paper sticking to the points and hold them apart from making good electrical contact.

If the contacts are burned unevenly, or very rough, it may be necessary to smooth them with a very fine platinum file. This should very seldom be necessary, but when it is done, just enough of the metal should be filed away to make the points smooth and square. Be careful not to round the edges.

The surface of a contact which is operating correctly will not be polished but will have a dull gray appearance, which a magnifying glass will disclose is caused by very fine "hills" and "hollows." This gray surface should extend over the whole area of the surface; if it covers but part of the surface it indicates that that is the only part that is making electrical contact. If this area of contact covers a third or more of the surface it should not be touched, provided the remainder of the surface is fairly smooth because as this limited area wears away naturally, more and more of the whole surface will come together. But if one of the contacts has a large "hill" and the other a corresponding "hollow" the file should be used to remove the "hill." Leave the other alone.

To adjust the contacts properly, one must have them clean, smooth, and sitting squarely together. The magneto should then be turned (by turning the engine if the magneto has not been removed from it) until the contacts are the maximum distance apart. A feeler gauge should then be inserted and if they are not the distance apart that the manufacturer recommends they should be adjusted by whatever means has been provided. This adjustment cannot be made correctly by guess or by eye measurement. A thickness gauge must be made. Most magneto manufacturers furnish these with the magnetos or they may be purchased for a small amount. A contact-point gauge is just as necessary to a magneto and, therefore, to the tractor, as a lifting jack is to a vehicle equipped with pneumatic tires.

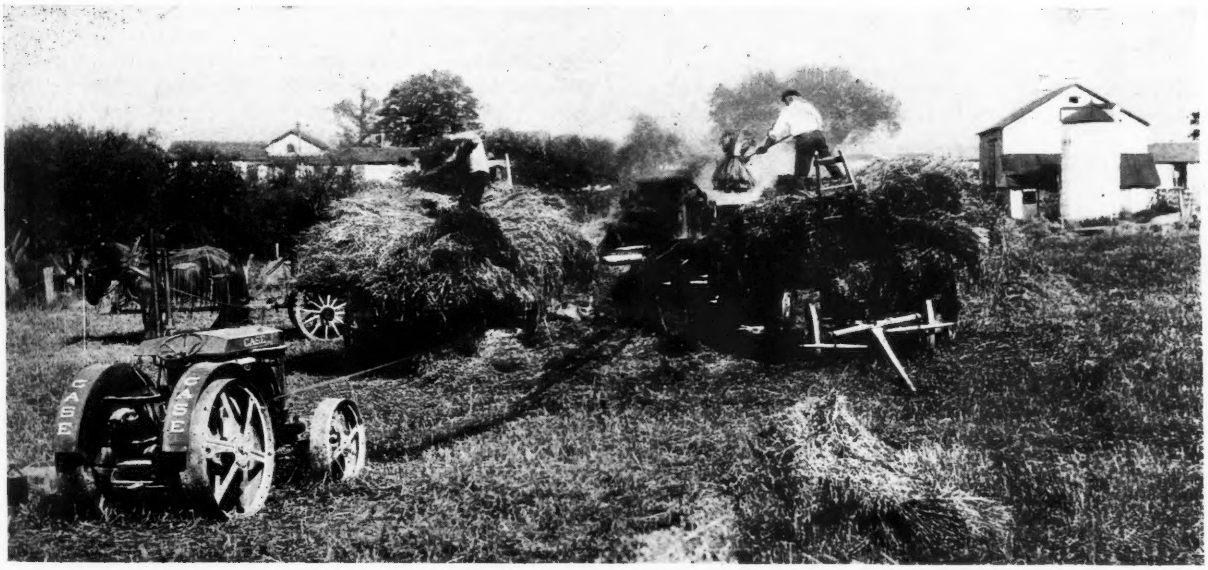
A word about the impulse starter. It is generally understood that its chief function is to spin the magneto momentarily at a high speed past the firing point, thus enabling the production of a hot spark for starting independent of the speed at which the engine is being cranked. But it is not so generally understood that a properly designed impulse starter also automatically retards the spark when in operation regardless of the position of the timing lever on the magneto at the time. It is not necessary to explain just how and why this is true, but it is well to have the fact generally understood as a mighty important feature of this auxiliary device.

There is no particular part of the impulse starter which needs the attention of the operator, other than periodic lubrication and cleaning, but should any of the parts break or get out of adjustment they should be repaired immediately. The tractor operator cannot afford to be without the use of this most important aid in starting his engine.

It will be noted that the foregoing treats the subject of tractor ignition almost wholly from the service standpoint. It is service that the farmer wants. He does not, or should not, care whether the magneto is blue or green, hard or soft, steel or brass, just so long as it gives him the sparks that he must have to operate his engine, run his tractor, plow his ground, sow his seed, harvest his crops, and make some money with which, generally, to buy another farm.

And it is from this standpoint that those coming into contact with the farmer can best cooperate with the tractor manufacturers to further the cause. Agricultural-engineering colleges need not attempt to teach the farmer of the future all about the intricate mechanism of the magneto or even of the simpler units of the ignition system, but if they will concentrate on the simple lesson of maintenance and teach that well there will be fewer cases of magneto trouble reported and more tractor operators satisfied with the ignition systems with which their machines are equipped.

Most of the magnetos on the market today are good magnetos. Some are a little better than others perhaps. But any of them will do what they were designed and built to do if the owner will oil them just enough, clean them, adjust the contacts, and leave them alone.



Agricultural engineers need not attempt to teach the farmer all about the intricate mechanism of the magneto, but if they will concentrate on the simple lesson of maintenance there will be little magneto trouble

Agricultural Engineering Development

A Review of the Activities and Recent Progress in the Field of Agricultural Engineering Investigation, Experimentation and Research

Edited by **R. W. Trullinger**

Mem. A.S.A.E. Specialist in Rural Engineering, Office of Experiment Stations, U. S. Department of Agriculture

USE OF MACHINERY IN LIFTING THE POTATO CROP. R. S. Seton and A. G. Ruston. (University of Leeds and the Yorkshire Council for Agricultural Education, Leeds, England, Pamphlet 114 (1920) pp. 28 figs. 9.) Comparative trials of four different types of potato digger are reported. These included (1) a rotary digger which breaks the potato ridge by a system of rotary arms revolving at right angles to the ridge and throwing the potatoes clear of the soil; (2) a scoop digger depending on a shaker or riddle at the rear to shake the earth through a series of prongs and to leave the potatoes clear upon the soil; (3) a machine which attempts to lift the ridge upon a moving elevator, the soil separating from the potatoes as they pass over the top of the elevator to the rear of the machine; and (4) a plain digger plow with a square pointed share which lifts the potatoes and forces them onto two sets of raisers, consisting of steel prongs set so as to resist and break the earth and lift the potatoes to the surface.

These machines showed the following average drafts: No. 1, 560 pounds; No. 2, 781 pounds; No. 3, 952 pounds; and No. 4, 448 pounds. The best all around results were given by machine No. 1, the rotary digger. No. 2, while embodying some excellent mechanical methods, failed to produce satisfactory results. No. 3 damaged the potatoes and had a very heavy draft. No. 4, the digger plow, was eliminated owing to its crudeness and lack of mechanical development. It lifted the potatoes and then covered them again, making additional labor necessary. The rotary digger was more effective with two heavy-draft horses than either No. 2 or No.3 machines with four horses.

It is concluded that all the principles involved in these machines need further development.

THE CARBURETION OF GASOLINE, O. C. Berry and C. S. Kegerreis (Purdue University Engineering Experiment Station Bulletin, 5(1920) pp. 223, figs, 104). A large number of tests are reported to determine the influence on the performance of an internal-combustion engine and its fuel requirements of changing the richness of the fuel mixture, the speed of the engine, the load on the engine, the temperature of the incoming air, and the temperature of the mixture by the hot-spot method. Different engines and carburetors were used in order to broaden the scope of the results.

It was found that there is a very definite range of fuel mixtures which will give the most power in any engine when the temperature of the mixture is such as to make proper carburetion possible. This range extends a little above and a little below 0.0775 of a pound of gasoline per pound of dry air. The richness of mixture for the highest power was not appreciably affected by the speed of or the load on the engine. It was affected by the dryness of the mixture, however, it being shown that with warm, dry mixtures an engine will pull well with mixtures that are leaner than can be used successfully when cold.

The effects of poor fuel distribution to the different cylinders by the intake manifold and of poor mixing of the fuel and air were found to be similar to those of using a cold mixture causing a waste of fuel in order to deliver highest power. The uniformity of the mixture of fuel and air in each cylinder was also found to be an important factor in the richness of the mixture delivering the highest power.

"The design of the carburetor and engine, especially the intake manifold, may and usually does affect some or all of these factors, and through them the richness of the mixture for highest power. By using a high grade of fuel or a warm mixture or both, these effects may be eliminated and under these conditions the design of the carburetor or engine does not seem to have any effect. * * * * * The range of mixtures through which approximately full power will be produced is quite wide, the richer mixture containing nearly twice as much fuel as the leaner ones. This range will vary somewhat with the brake load carried, being widest at about half load, where with a dry mixture the engine will fire regularly at 0.055, pull nearly the highest load between 0.065 and 0.115, and continue to fire regularly up to 0.1275. At full load this range is diminished slightly, but at a very light load it is cut down for regular firing to between 0.07 and 0.095, and will miss badly at 0.065."

A large amount of graphic and tabular data is reported which show the details of these experiments.

TRACTORS IN CONNECTICUT, W. T. Ackerman (Connecticut Agricultural College, Extension Bulletin 25 (1920), pp. 16, fig. 1, Storrs, Connecticut). Data are presented which were obtained from detailed reports from forty-five Connecticut farms on which fifty-nine tractors are operated.

It is estimated that the average life of a tractor in Connecticut is seven years. The tractor for field work is best adapted to seedbed preparation. The most satisfactory results have been obtained on farms with each tractor caring for an average of 76.5 acres. The most popular and satisfactory horsepower rating varies from 8-16 to 12-22. The three-plow tractor has given the best results. More than 82 per cent of the farms reporting used the tractor for belt work to good advantage. It has been found that the tractor to be successful should be used at least from ninety to a hundred days per year. A total of 101 horses on thirty-two farms were displaced by tractors, averaging 3.3 per farm and 2.4 per tractor. Approximately three and a half gallons of gasoline or kerosene, one quart of oil, and five cents worth of hard grease are required to break an acre of ground.

AUTOMOTIVE IGNITION SYSTEMS, E. L. Consoliver and G. I. Mitchell (New York: McGraw-Hill Book Company, Inc., 1920. pp. x + 269, Figs. 357). This book was prepared in the extensive division of the University of Wisconsin, and deals with the ignition systems used on tractors, trucks, automobiles, and airplanes.

The authors had in mind the needs of men who have to install, adjust, and repair ignition systems, and the book is therefore written essentially from the practical viewpoint.

Its scope is indicated by chapters on the principles of electricity and magnetism, ignition batteries, the jump-spark-ignition system, modern battery-ignition systems, battery-ignition systems for multiple-cylinder engines, the low-tension magneto, modern high-tension magnetos—armature and inductor types—care and repair of ignition apparatus, and ignition troubles and remedies.

CRUSHING STRENGTH OF SOUTHERN PINE AT ANGLES TO GRAIN, Q. C. Ayres (*Engineering News-Record*, 85 (1920, No. 14, pp. 653, 654, figs. 2, New York. Tests at the University of Mississippi of the compressive strength of Southern yellow pine on surfaces at angles at 0, 15, 30, 45, 60, 75, and 90 degrees to the grain are reported.

It was found that the specimen tested parallel to the grain failed by sliding along a plane oblique to the grain, while all other specimens failed by shear along a plane parallel to the fibers. There was a fair agreement between the test values and those computed from the Howe formula. This formula gives values which err on the side of safety, and is considered the best and simplest expression for use in dealing with Southern pine. It is as follows:

$$n = q + (p-q)\left(\frac{\Theta^0}{90^0}\right)^{5/2}$$

in which p = allowable intensity of stress in end bearing, q = allowable intensity of stress in cross bearing, and n = allowable intensity of stress on a surface inclined at an angle Θ to the grain.

THE FLOW OF WATER IN CONCRETE PIPE, F. C. Scobey (U. S. Department of Agriculture, Bulletin 852 (1920), pp. 100, pls. 12, figs. 3, Washington, D. C.). Part I of this report deals with the flow of water in concrete pipe under pressure. The results of 130 observations on thirty separate pipe, of which twenty-nine ranged from 8 to 63.5 inches in diameter and one was 120 inches in diameter, are presented. The mean velocities ranged from less than one foot to more than nine feet per second. Seventeen pipe were of the dry-mix, cement-washed, jointed types; five were of the wet-mix, oiled-form, uncoated jointed type; three were constructed in the same manner and then washed with cement; one was of the wet-mix, monolithic, steel-form, coated type; three were of the wet-mix, monolithic, wood-form, uncoated type; and one of the same construction coated. All but two of these pipes were under pressure.

On the basis of these experiments the following formulae, which differentiate between various classes of concrete pipe by means of a coefficient of retardation, were derived:

$$V = Cs\ H^{0.5}\ d^{0.625}$$

$$H = \frac{V^2}{Cs^2 d^{1.25}}$$

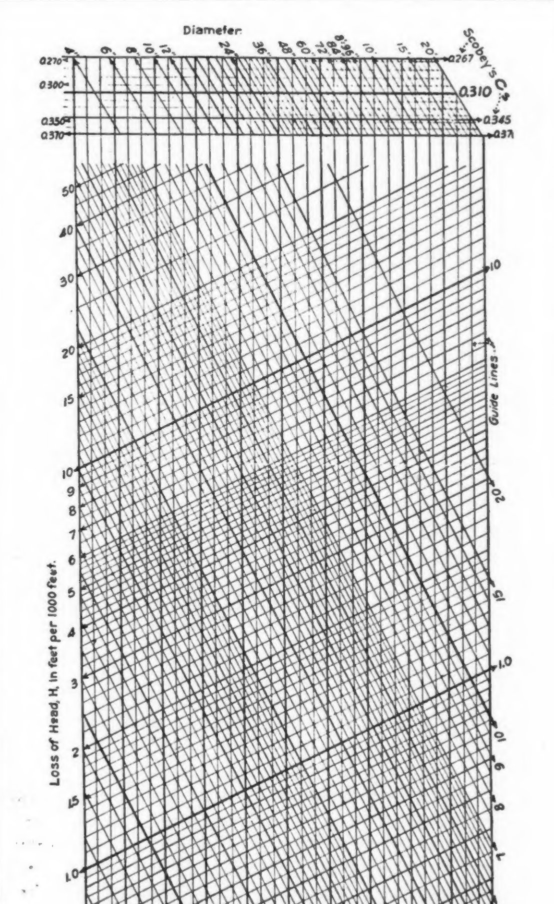
$$Q = 0.00546\ Cs\ d^{2.625}\ H^{0.5}$$

In these V is the mean velocity of the water in feet per second, H is the head of elevation lost through friction per 1000 linear feet of pipe, d is the mean diameter of pipe in inches, Cs is the coefficient of retardation, and Q is the mean discharge of the pipe in second-feet.

The pipe tested were found to fall into four different classes with reference to conditions covering the coefficient of retardation. Those falling in class 1, which are old California cement pipe lines with rough joints, are given a coefficient of retardation of 0.267. Class 2 pipe, or modern dry-mix concrete pipe and monolithic concrete pipe and tunnel linings made over rough wood forms, are given a coefficient of retardation of 0.31. This class also includes pipes with surfaces as left by the cement gun process and two-foot pipe sections of dry mixture washed with cement mortar on the inside. Class 3, or small wet-mix pipe in short units and dry-mix pipe in long units, are given a coefficient of retardation of 0.345. This class also includes average monolithic pipe made on steel forms, small cement-lined iron pipe, and concrete pipe made under pressure with interior coating of neat cement applied with a mechanical trowel. Class 4, or glazed interior pipe and large cement-lined iron pipe, are given a coefficient of retardation of 0.37. This class also includes monolithic pipe lines where joint scars and all interior or surface irregularities are removed and jointed lines of units made from wet well-spaded concrete deposited against oiled steel forms.

Data are given on design of concrete pipe lines based on the formulas derived in these experiments. (See accompanying diagram.)

Part 2 of the report deals with the flow of water in grade



From the intersection of the diameter and Cs follow guide lines to the intersection of H and V, or from the intersection of H and V follow guide lines to the intersection of diameter and Cs. No straight edge required.

line pipe, or pipe partially filled. In this work the coefficient of retardation was computed from five of the best known formulas in use in this country for the design of open channels. It is the opinion of the author that the Kutter, Manning, and Williams-Hazen formulas can be applied with much more accuracy than the Hazen formula if a constant retardation factor is to be used for a given surface. The Kutter formula appears to be applicable and, owing to its universal use, the following values of *n* are recommended: 0.0115 for glazed pipe, practically perfect in both surface and joints, and conduits carrying filtered water or water from which deposits or growths do not accrue; 0.012 for well-made pipe and conduits, with first-class joints, and good surfaces, and smooth monolithic pipe or tunnels, when new and clean for waters from which deposits are not expected; and 0.013 for well-made pipe, carefully jointed or monolithic without appreciable shoulders, for water containing a small amount of sewage. This value may be used also for designing sewers where conditions are such that high velocities may be attained with flushing streams. It is also applicable to storm sewers which carry but little deposit-creating material at peak load, but which may have a heavy deposit of grease at the high-water line of ordinary sewage flow.

It is concluded that the same values of *n* may be used in the Manning formula for this purpose as are used in the Kutter formula. In the use of the Williams-Hazen formula, values of the coefficient of retardation of 140, 130, and 120 are recommended for the conditions described for the values of *n* in Kutter's formula.

Abstracts of reports of experiments made by agencies other than the Irrigation Investigation Division of the Bureau of Public Roads covering tests made on pressure pipe and pipe partly filled are appended, together with discussions of the entire report by K. Allen, A. S. Bent, F. C. Finkle, A. Hazen, J. B. Lippincott, and H. D. Newell.

THE BULL AND THE TREADMILL, O. Tretsven and H. E. Murdock (Montana Station Circular 93 (1920) pp. 7, figs. 5, Bozeman, Montana). Three years' experience at the station farm in working a dairy bull for exercise on a treadmill and the results of recent experiments to determine the mechanical horsepower thus generated are reported.

It was found that a two-year-old Holstein bull was able to operate a feed cutter, root slicer, and the vacuum pump of a mechanical milker. It was necessary to use a gasoline engine to relieve the bull toward the end of each working period until he became accustomed to the task. To prevent him from stopping an automatic slapper was used which was set across the rack behind the bull and so arranged that when he stopped walking his thighs brought pressure upon the mechanism which recoiled and released a spring, thus giving him a hard slap. The slapper automatically cocks itself for further punishment. The time required to oil, start, operate, and stop the treadmill was found to be no greater than that for gasoline engine when the time required to keep the engine in condition was considered. It was found that daily exercise in a treadmill keeps the bull tractable and in good physical condition.

It is concluded that the power is well suited for operating cream separators, water pumps, mechanical milkers of a size within the capacity of the bull, and other light-running machines on the farm. Treadmills with flat treads were found to be preferable as they prevent slipping. To determine the power developed by bulls in a treadmill a series of experiments was conducted with a Holstein bull weighing 2060 pounds and a Jersey bull weighing 1250 pounds. The angle of the tread was varied to cover all those most likely to be used in practice as well as with various speeds of the bull. A prony brake was used and the results are graphically reported.

It was found that the force on the brake was about constant for a given angle for each bull. A speed of sixty revolutions per minute, which represented a walking speed of the bull of one mile per hour, seemed to be about the best. The average horsepower developed by the 2060-pound bull at that speed varied from 0.75 to 1.02 for the slopes varying from 20 to 25.1 per cent, and that developed by the 1250-pound bull varied from 0.42 to 0.62. The mechanical efficiency also increased slightly as the slope was increased and was a little higher for the heavier animal.

HANDBOOK OF BUILDING CONSTRUCTION, G. A. Hool and N. C. Johnson (New York and London: McGraw-Hill Book Company, Inc. 1920, 1, pp. XLIV+802, figs. 1016, II, pp. (2)—803-1474, figs. 407). This work in two volumes is intended to provide the architect, engineer, and builder with a reference covering the design and construction of the principal kinds and types of modern buildings and their mechanical and electrical equipment.

Part I deals with design and construction, Part 2 with estimating and contracting, and Part 3 with mechanical and electrical equipment. Part I contains sections and structural theory, designing of structural members and connections, structural data, general designing data, construction methods and equipment, and building materials. A large part of the data presented in this work should be of special interest to agricultural engineers engaged in the design and construction of farm structures.

IRRIGATION INVESTIGATIONS, G. E. P. Smith and W. E. Code (Arizona Station (Tucson) Report 1919, pp. 447-455, Fig. 1). This report includes, among other things, data on ground water supply and stream flow in the Casa Grande Valley and on tests of cement pipe.

Tests of eight-inch pipe of twenty varieties that had been buried in a drain in alkaline soil for six years showed that there was no evidence of disintegration. There was a marked difference in the appearance of the fractured samples. The more porous tile appeared damp or wet and showed more or less alkali in the fracture, while the denser tile were dry and free from alkali. The densest and strongest tile were those which had been mixed with a quaking or wet consistency. The opinion is expressed that drain tile for strongly alkaline soil should be mixed wet. Where tile had been dipped in or painted with cement grout, the grout was intact. A tar coating was less effective than the grout, and ferrous sulphate in the mixing water was found to be of no value.

RESULTS OF RUN OFF EXPERIMENTS WITH MUCK SOIL (*Engineering and Contracting*, Chicago, 55 (1921). No. 15, pp. 363-365, Fig. 1.) This is an abstract of a paper presented by F. C. Elliott before the Florida Engineering Society, in which experiments on the determination of run-off from muck soils, such as occur in the Florida Everglades, are reported.

The principal factors studied were storage and evaporation of moisture, the most advantageous water level for growing crops, and subsidence of muck soils under drainage and cultivation. The apparatus used consisted of a water-tight, sheet-iron box two feet square and four feet deep filled with a section of muck soil in its natural condition, growing grass.

It was found that muck soil has a very important storage capacity for moisture when the water table is at a favorable level. The records of the soil boxes showed in the beginning on virgin muck soil that each three inches of soil above water level was capable of storing one inch of rain. Later, after the soil became more compact by tillage and drainage, the storage factor was reduced to 1.4, and finally to the ratio of 1:5, which latter has been maintained for the past three years. It is concluded (1) that the storage capac-

ity of muck soil is a drainage factor of considerable value, varying directly as the depth of soil above the water table; (2) that in designing a drainage system for muck land, account may be taken of the storage value of the soil, provided ditches of relatively deep section are used and at sufficiently close intervals to secure a good depth of water table and for restoring and preserving the storage value of the soil; (3) that soil storage tends to equalize run-off, and the effect of the same will extend to the main canal system as well as to the lateral system; and (4) that deep soil above the water table is a tremendous protection against flood.

Leveling data showed that subsidence varying in amount from 2 to 3 ½ feet took place during six years on drained land in the upper Everglades. Subsidence apparently takes place from the surface downward and is confined almost entirely to the zone above water level. Ditch capacity is reduced by diminished depth and slope. The lower the water table, the greater and more rapid was the subsidence, and vice versa. The data indicate that too deep drainage should be guarded against, not only from the standpoint of subsidence but also because muck was found to resist the reabsorption of moisture once it becomes too dry. The kind and intensity of cultivation also affected the amount and rate of subsidence.

On the basis of these studies a drainage layout is suggested for muck soils, in which drainage capacities are represented by the equation $D = \frac{12}{1 + \sqrt{A}} + 16$, in which D is the discharge in cubic feet per second per square mile and A is the area in square miles. In this layout the maximum water level in ditches is to be one foot below the ground surface, the depth of lateral ditches not less than 5½ feet, and their spacing not over one-half mile. The water level is to be reduced before the beginning of the rainy season to not less than fifty inches below the surface. The depth of farm ditches is to be not less than 4½ feet and the spacing not over 660 feet. "In virgin muck soil eight feet or more in depth the ditches should be cut eight feet deep in order to have as much as 5½ feet after three or four years of drainage and cultivation, and this minimum depth of 5½ feet must be preserved, and can be through maintenance from time to time. Where partial subsidence has already taken place allowance may be made accordingly. Ditches within reasonable limits and where practicable should be deep and narrow rather than broad and shallow."

SUPPORTING STRENGTH OF DRAIN TILE AND SEWER PIPE UNDER DIFFERENT PIPE-LAYING CONDITIONS, W. J. Schlick (Iowa Engineering Experiment Station, Bulletin 57 (1920), pp. 68, figs. 32, Iowa State College, Ames, Iowa). Investigations are reported which were undertaken primarily to determine by actual tests the relation of the ordinary supporting strength, as given by standard laboratory tests, to the supporting strengths developed by pipe under ordinary pipe-laying conditions, to determine the definite ratios thereto of the supporting strengths developed with ordinary pipe-laying methods, and to determine the most economical methods of increasing the supporting strengths of pipe.

The pipe used were classed as hard-burned shale and varied in size from eighteen to thirty-six inches. Pipe were placed in actual shallow trenches under different pipe-laying conditions and loaded to cracking in all cases, and to complete collapse in all but a few instances. It was found that the foundation area to which the load on the pipe is transmitted and the uniformity of the distribution of this pressure have a marked effect upon the supporting strength of the pipe. A high supporting strength was found to require a wide and uniform distribution of the pressure between the pipe and the bed upon which it rests.

It is considered both practicable and desirable to group pipe-laying methods into classes. Methods of laying in earth are classed as ordinary, first-class, and impossible. The ordinary class is that in which the underside of the pipe is carefully bedded in soil for from sixty to ninety degrees of the circumference. The first-class method is that in which the underside of the pipe is very thoroughly bedded in soil for at least ninety degrees of the circumference. The impermissible methods are those in which the bottom of the ditch is not suitably rounded to fit the underside of the pipe. Pipe-laying methods in sand and gravel should be of the first-class type, but their use is restricted to cases where hub-and-spigot sewer pipe are used and the joints filled. Concrete cradle pipe-laying methods are classed as combined earth and concrete cradle, concrete cradle for any soil, concrete cradle for firm soil, and concrete cradle for yielding soil.

The investigations showed that the side support or resistance to horizontal thrust obtainable in most soils is of little value in increasing the supporting strength of the pipe before cracking. When pipe were incased in concrete the pipe and the concrete acted as a unit in resisting the deformation due to the load upon the pipe, thus increasing the supporting strength. The supporting strength of a cracked pipe was found to depend upon the bearing power of the soil at the sides, irrespective of the method of pipe laying and upon the length of the time of continuous application of the maximum load. The presence of concrete at the sides of the pipe provides for a wider distribution of the side pressure which in some soils resulted in a high supporting strength for a cracked pipe. The supporting strength of drain tile and sewer pipe laid by the ordinary method is concluded to be the rational basis from which to calculate the supporting strength of the same or similar pipe under any pipe-laying conditions. The safe supporting strength (using a factor of safety) of drain tile or sewer pipe is concluded to be the supporting strength before cracking. The supporting strength after cracking was found to depend on the bearing power of the soil which may change under any of several conditions. It is concluded that a factor of safety of 1½ is both necessary and sufficient to prevent cracking. Thus the average supporting strength of the pipe used should be one and a half times the probable maximum load on the pipe.

Tests of the particular pipe-laying methods outlined showed that the supporting strength developed by drain tile and sewer pipe laid by the ordinary method is equal to the average ordinary supporting strength of the same or similar pipe as determined by the standard strength test using sand bearings. The first-class method of pipe-laying was found to increase the supporting strength from twenty to twenty-five per cent, while the supporting strength developed by pipe laid by the impermissible methods was only about eighty per cent of the ordinary supporting strength as determined by standard test. The supporting strength developed by pipe bedded upon and surrounded by sand was found to be approximately equal to that developed by pipe laid by the first-class method.

It is concluded that drain tile should never be placed in beddings of this kind. It was also found that the supporting strength of drain tile and sewer pipe can be increased from fifty to one hundred per cent by the use of properly designed concrete cradles.

A. S. A. E. and Related Activities

A. S. A. E. Committee Appointments

PRESIDENT E. A. White has appointed a nominating committee for the College Section of the American Society of Agricultural Engineers, consisting of Prof. H. H. Musselman, Michigan Agricultural College, East Lansing, Michigan, chairman; Prof. Daniels Scoates, Agricultural and Mechanical College of Texas, and Prof. L. J. Fletcher, University of California.

Council Meeting at Fargo

THE Council of the American Society of Agricultural Engineers held a meeting on June 28 at Fargo, North Dakota, during the tractor demonstration. The Council members present were President E. A. White, J. B. Davidson, I. W. Dickerson, Raymond Olney, and Frank P. Hanson. Discussion of a special grade of affiliate membership in the A. S. A. E. for county extension workers occupied a greater part of the time. The proposed amendment to the Constitution and other conditions outlined elsewhere on this page for county agents to affiliate themselves with the Society was approved and action taken to instruct the Secretary to send out a letter ballot to the entire Council immediately, and in case the Council approved the amendment the Secretary was instructed to send out a letter ballot to the voting membership of the Society.

Considerable time was given to a discussion of the work of committees and sections and other activities of the Society.

The matter of moving the Secretary's office to St. Joseph, Michigan, on January 1, 1922, was also discussed. The sense of the meeting was that this step should be taken but the matter was left to be definitely decided by the whole Council. The purpose of such a move is to have the Secretary's office and the publication office at the same place in order to eliminate the lost motion and confusion that now exists by having them separated at such a distance.

Amendment to Constitution for the Affiliation of County Agents

THE AFFILIATION of county agricultural agents, county farm advisers, or county extension agents, as they are variously called, as well as home demonstration agents, with the American Society of Agricultural Engineers has for some time been considered desirable by both these workers and members of the Society. Such affiliation seems desirable for the following reasons:

1. Inasmuch as they are frequently called upon to assist in solving farmers' engineering problems, county extension workers are in need of the best possible contact with and should have at their command all the sources of agricultural-engineering information available. The A. S. A. E. is the agency in the best position to establish such contact because its particular activities combined with the individual activities of its members render it the principal clearing house of agricultural-engineering information and the leading factor in agricultural-engineering development.

2. County extension workers represent the logical point of contact between the A. S. A. E. and the farmer.

3. It gives A. S. A. E. members more remote from the farm an opportunity for closer contact with and a better understanding of agricultural conditions and requirements from the agricultural-engineering point of view.

4. County extension workers are, for the most part, graduates of the state agricultural colleges whose training in animal husbandry, dairying, agronomy, etc., has been particularly emphasized but whose training in agricultural engineering has in most cases been at least meager. An affiliation with the A. S. A. E. will result in furnishing this missing link and enable these workers to become more effective in assisting farmers with their agricultural-engineering problems.

5. The one, all-inclusive purpose of the A. S. A. E. is the advancement of agricultural engineering. County extension workers through their personal contact with farmers are in the best possible position to spread the gospel of agricultural engineering and thus create both the desire and the demand for those things which the general term "agricultural engineering" typifies. More rapid advancement of agricultural engineering, as well as a more insistent demand from the farmer himself, is possible in this way, and it is this which affiliation of county extension workers with the A. S. A. E. will foster.

Recognizing the foregoing facts the Council of the A. S. A. E. has unanimously approved such affiliation and has voted to submit to the voting membership of the Society to be voted upon by letter ballot the following amendment to the Constitution:

EXTENSION AFFILIATES

C 48a The Council may authorize the affiliation with the Society, by group or individually, of persons who, at the time of application, shall be engaged as county agricultural agents or other county or local extension workers in the employment of local farm bureaus cooperating with the state agricultural colleges or the federal department of agriculture. Such affiliation shall be only for the period covered by such employment.

Such affiliation will be on practically the same basis as student branch members. That is, (1) "extension affiliates" will not be entitled to vote or hold office in the Society; (2) they will be entitled to all publications of the Society, except the annual Transactions; (3) the annual dues will be $2.00 a year with no admission fee; and (4) they will be permitted to organize into sections at the discretion of the Council.

Voting members of the Society will shortly receive from the Secretary a letter ballot calling for a vote on this amendment and your prompt attention to registering your vote is earnestly urged.

Meeting of A. S. A. E. Belt Machinery Committee

THE belt-machinery committee of the American Society of Agricultural Engineers held a meeting in Chicago, June 16, 1921. Those of the committee present were G. B. Gunlogson, chairman; H. M. Gehl, H. R. Robinson, Arthur Johnson, K. J. T. Ekblaw, A. B. Welty, and Chris Nyberg. Other members of the Society present at this meeting were

E. A. White, President of the Society, and Raymond Olney, chairman of the Standards Committee.

The purpose of the meeting was to outline and make arrangements for field tests of silage cutters and grain threshers with a view to using the results of the tests as a basis for arriving at a uniform method or formula for rating these machines. The meeting was divided into two sections, Mr. Gunlogson acting as chairman of the section devoting its attention to silage cutters and Mr. Welty took charge of the section on threshers.

At a joint meeting of the A. S. A. E. Standards Committee and a special committee from the ensilage machinery department of the National Implement and Vehicle Association held in Chicago July 13, 1920, the recommendations as a result of that meeting included the formula

$$\text{Tons per hour} = \frac{\text{Throat area x cuts per minute}}{10{,}000}$$

which was suggested as the possible basis for arriving at capacity rating (maximum) of silage cutters. This is merely a tentative formula, and the purpose of the proposed tests is to determine if the formula is correct, and to revise it if necessary to the results of the field tests.

Inasmuch as it has been agreed that the formula or whatever method of rating is recommended be based on results of field tests, the committee decided the first step to take was to outline a code or method of making the tests. In the opinion of the committee more tests are necessary than have already been conducted in order to develop a formula which will express capacity ratings of silage cutters. The formula recommended as the result of the meeting last year, so far as the committee has been able to determine, is satisfactory but before it is finally recommended for adoption it was deemed advisable to make further tests.

The question of throat heights was discussed and the feasibility of arriving at some standard relation between height of throat and diameter of the cutting device. It was agreed that this matter could be settled after more complete data from tests to be made is available.

Another feature of considerable importance in the opinion of the committee is the design of the feeding mechanism, especially with reference to auxiliary feed rolls, and it is desired to get some data from the tests regarding this feature.

It was unanimously agreed by the committee that it was important to have comprehensive rules covering these field tests so that all tests made will be conducted along the same lines and the results be comparable. The data to be gathered in these tests will come under the two general heads of specifications and conditions of the tests. The specifications will include make and size of cutter, type (cylinder or flywheel), number of knives, width of throat, throat height (maximum), with or without auxiliary rolls, type of bearings (plain or anti-friction), size of drive pulley, and length of blower pipe. The committee agreed that the power rating of a silage cutter should be based on a forty-foot pipe instead of a forty-foot silo, as was stated in last year's recommendations. It is also intended that other tests will be made with different lengths of pipe.

Under the heading, "Conditions of Tests," the committee recommended the following outline:

(1) A four-hour continuous test for each machine will be considered the minimum length of test.

(2) The condition of the corn should be carefully and completely recorded. The test should be made with the entire corn plant, before frost, in best condition for silage, without water and in what is known as the early dent stage. All corn shall be weighed, the method of weighing recom-

Members and student branch members of the American Society of Agricultural Engineers at the University of Missouri

mended being to weigh several average bundles and use this as an average for finding the total weight of all the bundles in the load.

(3) The power consumed in these tests should be calculated as closely as possible by using an electric motor, or possibly a belt dynamometer. Where such devices are not obtainable the power should be estimated as closely as possible by using an engine that has been carefully tested for brake horsepower and the operator made familiar with its performance at various loads to enable him to estimate closely the power being developed. When this means must be used it is suggested that an engine of such size be employed as will require its developing close to its maximum power when operating the cutter. The speed of the engine should also be recorded while making the test.

(4) All tests should be made using the one-half-inch cut.

(5) Position of blower pipe should be vertical.

(6) The speed of the cylinder, or flywheel in case of the flywheel type of cutter, should be carefully recorded.

(7) The height of the throat opening during the test should also be noted.

The committee will prepare suitable data cards for collecting the data while making the tests, as well as complete report blanks to be made out at the completion of the tests. The data from all tests will be furnished all those manufacturers making tests or participating in the work. Manufacturers will thus have data on a number of types of machines besides their own. All reports or data sent out will be identified by number only. Manufacturers will be asked to make tests and will be given assurance by the committee that any standardization will not be at the sacrifice of the individuality of any manufactured machine. The manufacturers will be requested to make these tests in order to enable the committee to arrive at satisfactory conclusions from the standpoint of both manufacturer and the farmer.

The committee will also undertake the preparation of a bibliography of publications on silage, silos, and silage machinery. It was the sense of the meeting that the term "silage" become the accepted practice in the industry instead of "ensilage," and also that the term "silage cutter" become accepted practice in preference to "silo filler" or "ensilage cutter." The committee also recommends that the accepted terms for the two types of cutters be "cylinders" and "flywheel."

The committee will endeavor to get the attitude of manufacturers of silage cutters on the proposed standardization of piping and filling equipment, and endeavor to learn what length of pipe and distributor will be preferred.

An effort will be made to have tests conducted on certain large farms in Illinois and Wisconsin during the coming silage-harvesting season, at which time the committee will endeavor to get several makes of machines together at one time so that members of the committee and others interested can attend and assist in conducting the tests. Such tests, however, will not interfere in any way with those which individual manufacturers will be requested to make on their machines, or with those which A. S. A. E. members at the state agricultural colleges will be asked to make.

The next meeting of the committee will be held some time during the silo-filling season, the date to be announced later.

The subcommittee on grain threshers, recognizing the wide variation in the rating of thresher capacities and power requirements, devoted its attention during the meeting to finding means of arriving at a more satisfactory and uniform method of rating threshers as to capacity and power. On account of the great number of factors that enter into capacity and power required, such as kind and condition of grain, width of cylinder, etc., it was considered impractical to adopt a set of rules or a formula for determining capacity and power until a series of standards and satisfactory tests could be made on different makes of threshers, and under various conditions of grain, etc. The following tentative code was outlined for conducting such tests, which the subcommittee recommended be submitted to manufacturers and others interested, requesting their cooperation arriving at a satisfactory testing code.

(1) Record accurately and at frequent intervals, if not continuously, the power required to run a threshing machine both idle and at full capacity.

(2) To obtain the power required some form of transmission dynamometer was recommended which should be easily transportable so as to make it available for tests on other makes of machines, and for any condition under which a test might be desirable. If an electric motor is available such power would be preferable.

(3) Record the capacity of the thresher in bushels per hour.

(4) Kind and variety of grain.

(5) Condition of grain (whether damp, dry, or very dry.)

(6) Whether grain is in bundles or headed.

(7) Weight of straw per bushel of grain.

(8) Length of straw (to be determined by taking a small handful of straw from twelve bundles and getting an average from this.)

(9) Size of bundles (measured by taking the average length of twelve bands.)

(10) If grain is stacked the number of days stacked previous to threshing should be recorded.

(11) While tests are being made the machine should be doing good work and not wasting more than one per cent of the grain.

(12) The speed of the cylinder in revolutions per minute should be recorded during the tests.

(13) Kind of attachments used (feeder, stacker, etc.)

The subcommittee recommends that the agricultural engineering departments of the state colleges be intrusted in carrying out tests according to this recommended code.

The question of adopting a limited number of sizes of sprocket chains was considered. The effect of standardizing sprocket chains should ultimately result in the elimination of many sizes now manufactured and used only in small quantities. Such elimination should also reduce the cost of standardized sizes and result in a better product. Moreover, the dealer could more readily determine his requirements to supply the users' needs, thus avoiding many delays in farming operations. It was suggested that five sizes of chains are enough to meet practically all conditions. In this connection, it seems advisable also to consider the chains most generally used on other lines of farm machines, such as grain binders, etc.

The question of belt widths for driving parts on threshers was also discussed. The widths favored as standard are 1½, 2, 3, 4, and 5 inches. In the case of rubber or fabric belts the 1½ and 2-inch sizes should be three-ply and the others four-ply. If leather belts are used all should be single.

The question of some standard design for pulleys was discussed briefly but it seemed to be of secondary importance at this time.

A. S. A. E. Exhibit at Fargo

THE American Society of Agricultural Engineers was represented at the tractor demonstration at Fargo the last week in June by an exhibit in the accessories tent in charge of Secretary Frank P. Hanson. A great deal of credit is due Mr. Hanson for the time and care which he took in preparing material for the exhibit. Several charts were on display the majority illustrating farm equipment standards,

which comprised the elimination of the cutaway disk harrow, wagon standards, vertical height and lateral adjustment of tractor drawbar hitches, elimination of the left-hand plow, and standard belt speeds. Charts were also shown representing the effective speed on plows, and the draft of plows. A complete index of AGRICULTURAL ENGINEERING to date was prepared and effectively displayed, including particularly a list of power-farming subjects. An index of A. S. A. E. Transactions was also a part of the exhibit.

While no special effort was made to have the members of the Society present at the demonstration register, twenty-nine names appeared on the register, which did not include all who were present.

Licensing Engineers

AT THE executive board meeting of the American Engineering Council of the Federated American Engineering Societies held in St. Louis, June 3, a resolution was passed requesting the committee on the licensing of engineers to hold a hearing in the near future, at which time all interested might present their views as to the licensing of engineers. The chairman of the licensing committee is now developing plans for such a hearing, the time and place to be announced later. In the meantime, the committee desires to get in touch with all those who are interested and obtain from them a written statement as to their views concerning the several phases of the licensing of engineers.

Inasmuch as many of the members of the American Society of Agricultural Engineers have been and are now very much interested in the matter, the committee on licensing of engineers would appreciate receiving from them such a written statement as they desire to make on the subject. The Secretary of our Society is requested to send the committee a list of those A. S. A. E. members that should be invited to the hearing or should receive special notice. Any A. S. A. E. member who wishes to be present at the hearing is requested to advise the Secretary, Frank P. Hanson, at once, and also if you desire to submit a written statement on your views concerning the licensing of engineers this should be done promptly and mailed to L. W. Wallace, executive secretary, The Federated American Engineering Societies, 719 Fifteenth Street, N. W. Washington, D. C.

Smithsonian Physical Tables

THE seventh revised edition of the Smithsonian Physical Tables represents a considerable enlargement of earlier editions. Not only have the older tables been enlarged by the substitution and addition of new data, but about one hundred and seventy new tables have been added to the book. The present edition has an entirely new arrangement of tables, the rearrangement being more logical and greatly facilitating the use of the book for reference purposes.

The tables are gathered under the broad heads of mathematical tables, mechanical properities, compressibility of gases, densities, barometric tables, acoustics, aerodynamics, viscosity, vapor pressures, thermometry, melting and boiling points, thermal conductivity, expansion coefficients, specific heats, latent heats, heats of combustion, formation, etc., radiation, cooling by radiation, conduction, and convection, the eye and radiation, photometric tables, photographic data, spectrum wave-length, indices of refraction, reflecting power, transmissive powers, electomotive powers, electrical resistance, wire tables, electrolysis, dielectric strength, dielectric constants, wireless telegraphy, magnetic properties, magneto-optic rotation, various magnetic effects, a number of classifications dealing with radioactivity and related topics, molecular, atomic and ionic data, colloids, astronomical, meteorological and geodetical data, and terrestial magnetism. Except for the introduction of some forty-six pages and the appendix, consisting of definitions of physical terms, the book contains nothing but tables and their accompanying notes. The logical arrangement, the comprehensive table of contents and careful indexing make it a very accessible work. It has nearly five hundred pages, but in spite of this presents the modest exterior appearance of a blue cloth covered book about one inch thick.

The value of the tables to the engineer probably will be found not so much in the considerable proportion of data which is recognized instantly as being of an engineering nature, but rather in placing at his disposal other basic data which is needed only occasionally, but needed badly and not always easily located. The book is published by the Smithsonian Institution, Washington, D. C., and is distributed without charge to libraries. The price to individuals is $3.00.

Necrology

HARRY M. LYNDE

THE American Society of Agricultural Engineers sustains a keenly felt loss in the death of Harry M. Lynde, senior drainage engineer of the Bureau of Public Roads of the U. S. Department of Agriculture. His death occurred on May 17, 1921, funeral services being held at Christ Church, Raleigh, North Carolina, and interment was at Everett, Massachusetts, the family home. The Society was represented at the funeral by S. H. McCrory, chief of drainage investigations, U. S. Department of Agriculture, Washington, D. C.

Mr. Lynde was also a member of the American Society of Civil Engineers and the American Association of Engineers, of which the Raleigh Chapter attended the funeral. Although comparatively a recent member of the American Society of Agricultural Engineers, he has been active on both the membership and drainage committees, and has contributed to the programs to an extent which makes his death a substantial loss. Prior to his connection with the U. S. Department of Agriculture, Mr. Lynde was in the employ of the Catskill Aqueduct Commission. At the time of his death he was 38 years old. He is survived by Mrs. Lynde and a daughter.

Wanted—Correct Addresses of These A.S.A.E. Members

(NOTE: Mail is being returned from the addresses given below. These persons or others will be conferring a distinct favor if they will furnish at once correct addresses to the Secretary.)

Dale Allen, 1030 Bluemont, Manhattan, Kans.

George J. Baker, 122 Theodore St., Detroit, Mich.

Henry G. Cox, 117 Calendar Ave., La Grange, Ind.

J. D. Eggleston, 1638 Iowa St., Dubuque, Ia.

Donald McCluer, Box 302, West Raleigh, N. C.

J. H. Ney, International Harvester Co. Salt Lake City, Utah.

Raymond A. Wanek, University of Nebraska, Lincoln, Neb.

New Members of the Society

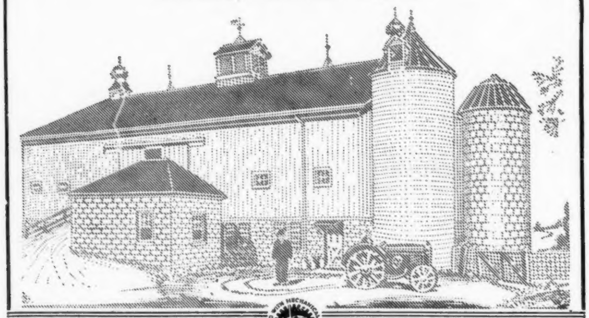
MEMBERS

Samuel H. Beckett, associate professor of irrigation, University of California, Davis, California.

James Elmer Dunn, traveling representative, Ford Motor Company, San Francisco, California.

Floyd Earl Fogle, assistant professor of farm mechanics, East Lansing, Michigan.

Wayne M. Hart, research work and patent attorney,



Cleveland Tractor Company, Cleveland, Ohio.

Orsel Edwin Robey, extension specialist in drainage, Michigan Agricultural College, East Lansing, Michigan.

Chauncey W. Smith, associate professor, University of Nebraska, Lincoln, Nebraska.

P. Arthur Tanner, mechanical engineer, Carson, Iowa.

Albert Charles Todd, factory sales manager, Moline Plow Company, Rock Island, Illinois.

Harry Bruce Walker, extension engineer in drainage and irrigation, Kansas State Agricultural College, Manhattan, Kansas.

Howard Lewis Waterman, assistant superintendent of experimental department, Emerson-Brantingham Company, Rockford Illinois.

ASSOCIATE MEMBERS

Arthur H. Carter, extension architect, Mississippi A. & M. College, Agricultural College, Mississippi.

Ed. Webb Farr, student and instructor, State College of Washington, Pullman, Washington.

Ross Carnes Ingrim, teacher, University Farm, Davis, California.

H. Z. Rynerson, instructor farm carpentry and mechanics, Iowa State College, Ames, Iowa.

AFFILIATE

Daniel Cromer Heitshu, student, Pennsylvania State College, State College, Pennsylvania.

CHANGE IN GRADE

Cecil Everett White, graduate student, University of Wisconsin, Madison, Wisconsin. (Changed from Student Branch to Junior Member.)

Applicants for Membership

The following is a list of applicants for membership received since the publication of the June issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send pertinent information relative to the applicants for consideration of the Council prior to their election.

George Norwood Allen, general superintendent, Walter A. Wood Mowing and Reaping Machinery Company, Hoosick Falls, New York.

Roy Gould Cullen, student, Ohio State University, Columbus, Ohio.

Harry Elden Orr, manager territorial department, Cleveland Tractor Company, Cleveland, Ohio.

Elbert Blodgett, superintendent and engineer, I. B. Rowell Company, Waukesha, Wisconsin.

Elmer Glover Helman, farming, Sedalia, Missouri.

LeRoy Fitch Beers, proprietor L. F. Beers Suburban Engineering, Rochester, New York.

Robert H. Black, in charge of grain cleaning investigations, U. S. Department of Agriculture, Minneapolis, Minnesota.

Guy Gregor Spokely, roadman, Ford Motor Company, Minneapolis, Minnesota.

A. M. Chase, automotive engineer, Ordnance Department, U. S. Army, Syracuse, New York.

William Henry McPheeters, assistant professor of physics, A. & M. College of Texas, College Station, Texas.